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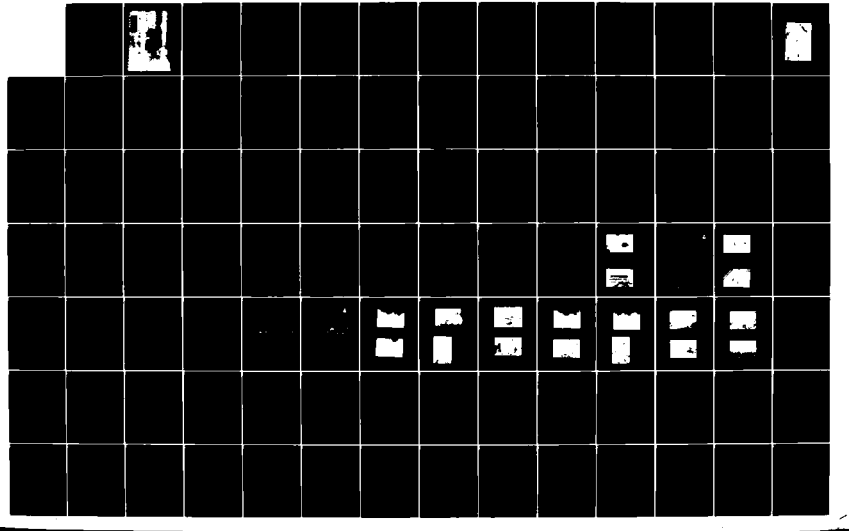

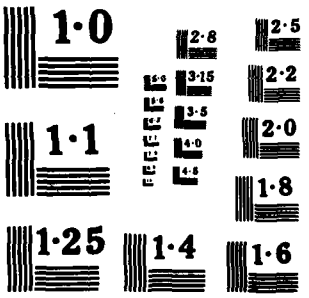
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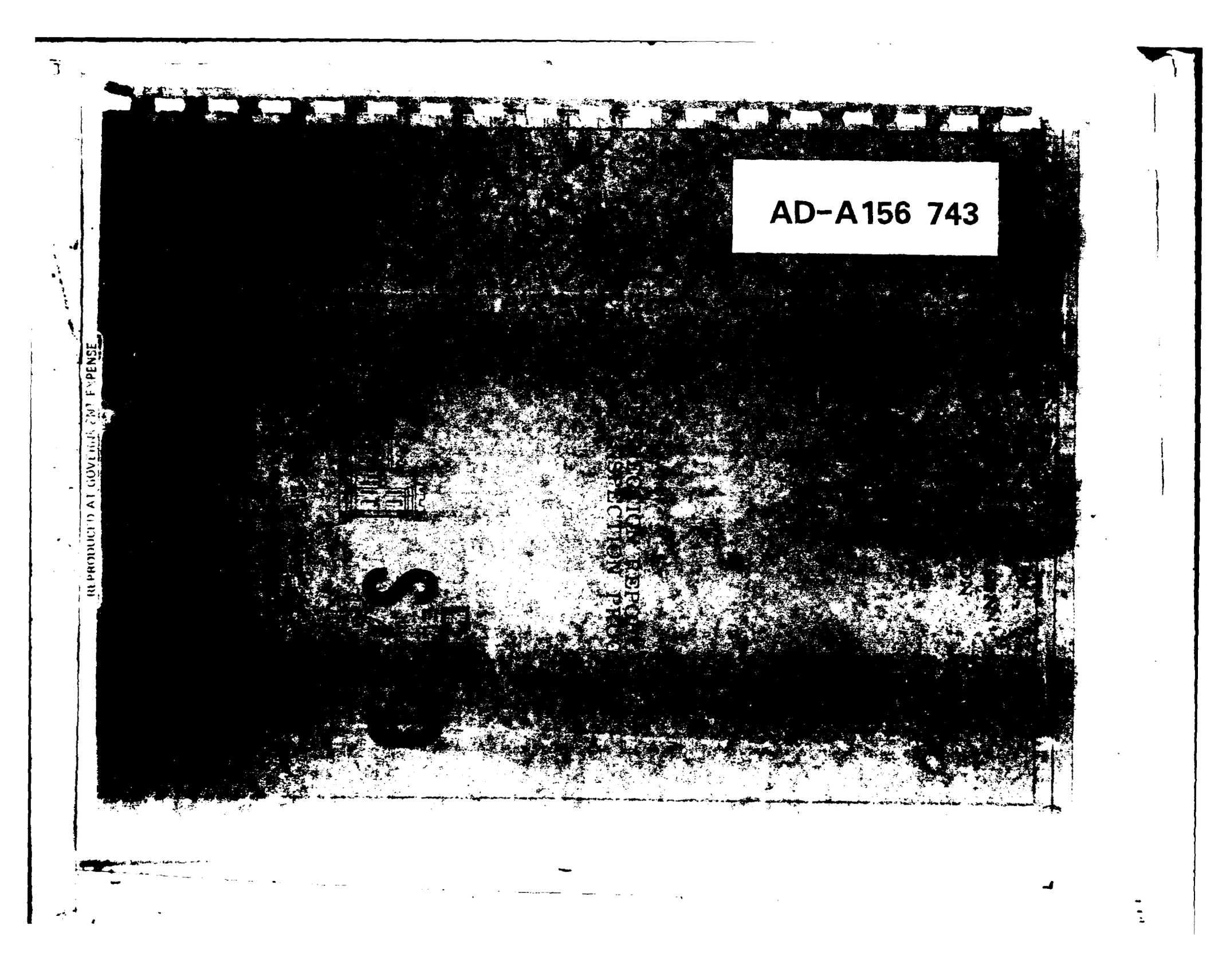

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Hudson River Basin
North Bennington, VT
Paran Creek

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is about 29 ft. high and 550 ft. long. On the day of the inspection a 7 ft. diameter hole was found just below water level on the upstream side. It is recommended that the lake level be maintained at the invert of the gate structure. The dam would be overtopped by 3.3 ft. during the test flood (½PMF).

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LAKE PARAN DAM

VT00006

NORTH BENNINGTON, VERMONT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DUFRESNE - HENRY ENGINEERING CORP.
INCORPORATED
1961
SPRINGFIELD, VT.

STATE OF VERMONT
WALTER A. HENRY, P.E.
No. 530
PROFESSIONAL ENGINEER

Walter A. Henry

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: VT 00006
Name of Dam: Lake Paran
Town: North Bennington
County and State: Bennington County, Vermont
Stream: Paran Creek
Date of Inspection: June 22, 1978

STATEMENT OF SIGNIFICANT FINDINGS AND BRIEF ASSESSMENT

This dam is about 29 feet high and 550 feet long. It was presumably constructed of glacial till between 1851 and 1855. Within about one year, it reportedly failed - killing one person - and was subsequently rebuilt. At the left side of the embankment there is a 90-foot long spillway with its crest 3.3 feet below the top of the dam. The water level on the day of inspection was just above the spillway crest. At the right end there is an inoperable gated outlet structure with invert 14.8 feet below the top of the dam and a 4-foot diameter corrugated metal pipe outlet. Heavy shrubs and trees cover the downstream slope, and shrubs are growing from the riprap upstream.

On the day of inspection, June 22, 1978, a 7-foot diameter hole was found just below water level on the upstream side. This hole tapered to a diameter of about 4 feet at a depth of 7 to 10 feet. Water was flowing into the hole, and a 1-inch diameter vortex formed intermittently near the middle of the hole. Thousands of gallons per minute of flow were observed exiting from the toe of the dam and up to 3 feet above the toe. The flow into the hole was estimated to be no more than 1/2 to 2/3 of the flow rate observed downstream.

The Corps of Engineers was notified of the hole in the morning on June 23, 1978 at which time the inspectors recommended that the lake be drained immediately below the level of the hole, or lower, as necessary to essentially eliminate seepage. A crew of two men was left on the dam on June 24 and 25. On June 26, 1978 the watch was assumed by the Chairman of the Board of Trustees, North Bennington, who began operations to lower the lake level on that day.

STATEMENT OF RECOMMENDED ACTION

It is recommended that the lake level be maintained at the invert of the gate structure, that the gate be left open, and that a carefully designed warning system be established and tested to allow evacuation of the downstream areas before the lake level rises to within 6 feet below the top of the dam. In addition immediate steps should be undertaken to provide additional outlets, since the dam would be overtopped by 3.3 feet during the test flood (1/2 PMF).

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: VT 00060
Name of Dam: Lake Paran
Town: North Bennington
County and State: Bennington County, Vermont
Stream: Paran Creek
Date of Inspection: June 22, 1978

STATEMENT OF SIGNIFICANT FINDINGS AND BRIEF ASSESSMENT

This dam is about 29 feet high and 550 feet long. It was presumably constructed of glacial till between 1851 and 1855. Within about one year, it reportedly failed - killing one person - and was subsequently rebuilt. At the left side of the embankment there is a 90-foot long spillway with its crest 3.3 feet below the top of the dam. The water level on the day of inspection was just above the spillway crest. At the right end there is an inoperable gated outlet structure with invert 14.8 feet below the top of the dam and a 4-foot diameter corrugated metal pipe outlet. Heavy shrubs and trees cover the downstream slope, and shrubs are growing from the riprap upstream.

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It is recommended that the lake level be maintained at the invert of the gate structure, that the gate be left open, and that a carefully designed warning system be established and tested to allow evacuation of the downstream areas before the lake level rises to within 6 feet below the top of the dam. In addition immediate steps should be undertaken to provide additional outlets, since the dam would be overtopped by 3.3 feet during the test flood (1/2 PMF).

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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LAKE PARAN DAM

NORTH BENNINGTON, VERMONT

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

There was no existing design data available for the structures at Lake Paran.

b. Experience Data

Other than an account of the dam failing soon after construction in the 1850's, no other information with respect to lake levels was available.

c. Visual Observations

At the time of the inspection the outlet gate structure was completely silted up and inoperable. The gate had not been open since its installation. Efforts to open the gate subsequent to the inspection to lower the lake level resulted in partial removal of the gate and destruction of the operating mechanism. The downstream outlet of the emergency drawdown structure was severely eroded and could collapse, resulting in limited service or total disablement of the outlet.

d. Overtopping Potential

Preliminary computations indicate that the test flood (one half of the probable maximum flood) will overtop the embankment by 3.3 feet.

Downstream flooding as a result of breaching of the dam would result in a flood wave 16 to 20 feet high. This flood wave would endanger the area shown striped on the Drainage Area Delineation Map (Appendix D). The height of this wave is based on the assumption that the wave would be 2/3 the dam height. Analysis by hydrographs was not possible due to the inadequacies of available mapping.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

There are no operational procedures known.

4.2 Maintenance of Dam

The grass and brush are cut to provide operation of train traffic.

4.3 Maintenance of Operating Facilities

The gated outlet structure was the most obvious item which had no maintenance for years.

4.4 Description of any Warning System in Effect

There is no warning system associated with this facility.

4.5 Evaluation

Maintenance and operational procedures are nonexistent. As a result the wood gate had to be cut open with a chain saw, which was an emergency operation.

From just above White's Mill to it's mouth, Paran Creek flows through populated areas.

The downstream channel below the outlet works is completely overgrown and covered with fallen trees. It is an unlined channel.

The channel downstream of the spillway was free of obstructions, although many trees are growing on both sides and overhanging the channel.

3.2 Evaluation

The small dams on Paran Creek downstream of Lake Paran would increase the hazard of any overtopping or failure of the dam at Lake Paran. This would result in an increase in flood damages resulting solely from Lake Paran.

It was determined that there is danger of failure of this dam due to the presence of the major hole in the embankment on the upstream side. Therefore, it was recommended to the Corps of Engineers, on June 23, 1978, the morning after the inspection, that the lake be lowered immediately to a level below the top of the hole, or lower if necessary, to essentially eliminate seepage, and that subsequently an investigation be made to establish further needed actions. The condition of the hole was monitored on June 24 and 25, hourly, day and night, until representatives of North Bennington assumed the observations. The lake lowering was started on June 26, 1978 under the auspices of the Chairman of the Board of Trustees of North Bennington.

Any loss of storage due to sedimentation would have little effect on the surcharge height produced by the test flood, therefore this potential problem is of little concern in evaluation of dam overtopping.

The downstream channel area contains debris which may accumulate at road crossings downstream during flood stages, resulting in reduced flow-carrying capacities.

Based on these visual observations, it appears that the dam must, for practical purposes, be redesigned and rebuilt. It may be possible to incorporate part of the present embankment into the final dam. Specifically, the following items are significant:

a. The seepage through the dam must be reduced and controlled.

b. The outlet conduit must be rebuilt to repair locations where erosion has occurred and to preclude future erosion.

c. The spillway discharge channel walls, and the soil behind them, must be redesigned to preclude the erosion and leakage that are occurring.

The trash rack was in relatively good condition.

The conduit leaving the gate was in good condition.

Directly leaving the gate structure was a 3' x 4-1/2' stone masonry conduit. There were no significant cracks observed and the alignment was good. At the point where there was a change in direction the conduit was continued as a 4-foot diameter corrugated metal pipe. This pipe may have a hole in it since an erosion gully has been formed above the pipe (see 3.1b).

The concrete headwall at the discharge end of the 4-foot diameter culvert has serious erosion problems, as the flow will drop vertically at the end of the concrete apron and then back under the structure (see photo #12). The flow has eroded a channel underground which exits approximately 15 feet downstream in the discharge channel.

d. Reservoir Area

The reservoir area consists of approximately 36 acres at the normal pool level. A considerable amount of aquatic growth and shoreline vegetation was visible around most of the lake with the worst being at the east end. Sedimentation has been a problem which had in the past been aggravated by a gravel operation on Paran Creek. A Vermont Fish and Game Department depth chart dated July 18, 1941 indicates a subaqueous channel on the east (left) end of the lake that had been 10 to 15 feet deep was now only 5 to 10 feet deep. In April of 1975 the Paran Recreation Department Incompany Cleanup Committee petitioned the State of Vermont Department of Water Resources to approve a dredging project. This was never carried out.

e. Downstream Channel

From the toe of the spillway for a distance of approximately 1/4 mile, the stream has a moderately steep gradient. The channel itself is free of vegetation, however, the overbanks are heavily vegetated with trees and dense brush which overhang the channel forming a canopy. The channel bottom contains cobbles and boulders.

Paran Creek enters a small 3-acre pond named White's Mill, 1/4 mile downstream from Lake Paran. From there Stark Mill Pond (3 acres), Cushman Pond (4 acres) and Polygraphic Pond (4 acres) are crossed before Paran Creek enters the Walloomsac River, approximately 1.5 miles below the Lake Paran Dam.

Photograph #7 is a view from left to right of the tracks. The slight downstream deflection of the track, approximately mid-point in the photograph, is located opposite the hole in the upstream face.

An erosion hole was found in the downstream face of the dam just over the top of the 4-foot diameter outlet conduit that is located at the right abutment. This hole was 2 feet wide along the dam, about 6 feet long, down slope, and at least four feet deep. The top of the hole is about 4 feet down slope from the downstream crest line.

Upon an inspection of the dam after drawdown another hole was found on the upstream face of the embankment (see photo #10).

Erosion holes were also found on both sides of the spillway discharge channel walls, upstream from the crest. These holes are up to 3 feet deep.

Additional zones of erosion were found on both sides of the outlet works discharge structure.

c. Appurtenant Structures

The general appearance of the concrete and stone masonry of the normal spillway is good. There were no cracks observed in the weir and the horizontal and vertical alignment were very good. One of the concrete walls which the weir ties into is cracked (see photo #4, Appendix C). The channel walls for the spillway discharge are comprised of a concrete section and a stone masonry section. Both sections are structurally sound. There are two substantial leaks in the masonry sections on the left abutment (see photo #3). There is a substantial hole on the right stone masonry abutment but no water was flowing during the time of inspection. The channel floor is composed of concrete just downstream of the spillway and hand placed marble blocks further downstream. The concrete was in good condition and not cracked. Also there was evidence of previous flow out of the interface between the downstream end of this wall and the abutting right embankment.

The general appearance of the concrete in the intake structure of the outlet works was very good. All aspects of the structure were examined. After the lake was lowered, a crack was observed in the wing wall of the gate structure (photo #12, Appendix C). There was no spalling of the concrete or obvious settlement of the structure. The slide or service gate was inspected but the equipment to test operation was not available. However, when the attempt was made to lower the lake, the gate was found to be inoperable.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

This dam is in imminent danger of failure when the reservoir is at normal level.

b. Dam

There is a major hole in the upstream face at a distance 265 feet right of the right wall of the spillway discharge channel. Figure 3 shows an estimated cross section of the dam at this location. The hole was visible just below the water surface on the day of inspection, June 22, 1978. The top of the hole was 7 feet in diameter and tapered down to about 3 feet in diameter at a depth of 7 to 10 feet, where it disappeared into the embankment. A fishline with a light weight on the end was dragged at least 25 feet into the hole by the current of water flowing into the hole.

Major outflow was occurring from the toe of the dam on the day of inspection. At that time heavy shrubs covered the entire downstream slope. Therefore paths were cut in a few locations to observe seepage from the toe. Approximately opposite the hole a major outflow was observed at the toeline of the dam and from a few feet up the face. The length of this zone of seepage was about 30 feet and thousands of gallons per minute were estimated to be flowing out. A portion of this flow is shown in photo #8. A second point of flow was found about midway between the spillway and the hole. The flow rate at this location was probably in the tens of gallons per minute. A third location of outflow was found about 100 feet to the right of the hole. Again tens of gallons per minute outflow was occurring from a zone near the toeline and two or three feet up the face. All flow was clear. It carried a few suspended particles but looked the same both upstream (in the lake) and downstream.

During a subsequent visit on June 25, 1978 a cloud of rusty water was placed in the hole upstream. In about 5-1/2 minutes, the rusty water was observed to exit from the downstream side. Based on the estimated flow velocity into the hole at the location where it was about 4 feet in diameter, and based on the volume of flow estimated in the stream at the toe of the dam, it appears that the flow into the hole was only one-half or two-thirds of the outflow. During our visit to the base of the dam on June 25, 1978, some cloudy water was seen, but it quickly cleared up.

SECTION 2: ENGINEERING DATA

2.1 Design

There are no documents available describing the design of this embankment. There are no existing plans on the spillway and no existing hydrological computations from a design phase. The gated outlet structure was reconstructed in 1956 because the previous structure was made of timbers and was rotting. These plans are available (see attached in Appendix B).

2.2 Construction

Refer to Section 1.2h for the construction history.

2.3 Operation

There are no known operational and maintenance procedures associated with Lake Paran Dam.

2.4 Evaluation

a. Availability

The plans for the embankment and the normal spillway are nonexistent or unavailable. The plans for the new gate works appear to be adequate, available and were prepared by a registered professional engineer. These plans are stored in the office of the Chairman of the Board of Trustees, North Bennington.

b. Adequacy

The lack of indepth engineering data does not allow for a definitive review. Therefore the adequacy of this dam, structurally and hydraulically, can not be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history, and sound hydrologic and hydraulic engineering judgement.

c. Validity

Not applicable.

to the downstream face which has a 1:1 slope (see Figure 1). Elevation of the weir is 646.8 feet above mean sea level, which is 3.3 feet below the top of the dam.

At a point approximately 30 feet downstream from the weir, the spillway discharge channel constricts to form a 35-foot wide rectangular channel. The flow is confined to this width to approximately 63 feet downstream of the weir, at which point the flow expands into the natural stream channel . Marble blocks have been hand placed in the channel just downstream from the center of the embankment to form the discharge channel.

j. Regulating Outlets

The regulating outlet in the abutment at the right end of the dam consists of a gate 4' 4" x 6' 0" and a box conduit 5' 3" x 4' 0". The entrance invert is at an elevation of ± 635.3 feet above mean sea level, 14.8 feet below the top of the dam (see photo #5 and Figure 2).

The conduit leading away from the gate is a stone masonry box culvert approximately 5' 3" x 4' 0" with a transition to 4' diameter corrugated metal pipe. There is a bend or change in direction at the transition in construction material. This pipe exits through a headwall on the downstream side of the embankment.

Subsequent to and as a result of the inspection on June 22, 1978 the outlet was opened, resulting in the destruction of the gate, gate stem, and operating mechanism. At that time it was not possible to open the gate, so a number of holes were punched through the gate with a battering ram and a portion of the gate was removed with a chain saw to lower the lake level.

g. Dam

(1) Type

According to verbal information provided by Mr. Bischoff of Vermont Railroads, the embankment is earth fill, composed of the local glacial till.

(2) Length

The overall length is 550 feet.

(3) Height

The maximum height is 29 feet.

(4) Top Width

The top width averages 23 feet.

(5) Side Slopes

Upstream - About 2.5H:1V
Downstream - About 1.4H:1V

(6) Zoning

None known.

(7) Impervious Core

None known.

(8) Cutoff

None known.

(9) Grout Curtain

None known.

(10) Other

According to Mr. Welling a row of timber piles exists just upstream of the railroad. This row was later buried.

i. Spillway

The spillway is an open concrete flume located near the left end of the dam. The overflow weir is approximately 90 feet long and is semihexagonal in plan. The weir has a vertical upstream face, is one foot wide at the top, and curved down

(2) Maximum Known Flood at Dam Site

No records of past flood discharges at the dam exist, however, the embankment reportedly washed out once within a year after construction, in the 1850's. The dam withstood the floods in November 1927, March 1936, and September 1938. However, the discharges from these storms at this site are not known.

(3) Spillway Capacity

With the pool at the top of dam, with zero freeboard, (approximately 650.1 feet m.s.l.) the spillway capacity is 1755 cfs. This result is based on the assumption that the Rutland Railroad bridge just downstream of the spillway does not become clogged with debris to control the discharge capacity. There is no trash rack or gate structure on the spillway.

c. Elevation Data

	Elevation (assumed) (feet m.s.l.)
Test Flood (1/2 PMF)	653.4
Top of Dam (Maximum)	651.9
Top of Dam (Minimum)	650.1
Recreation (Normal) Pool	647.0
Spillway Crest	646.8
Emergency Drawdown Upstream Invert	635.3
Streambed at Centerline of Dam	621.0

d. Reservoir Data

	Feet
Length of Pool at Top of Dam	3300 +
Length of Recreation (Normal) Pool	3300

e. Storage Data

	Acre-Feet
Test Flood (1/2 PMF)	464+
Top of Dam	345
Recreation (Normal) Pool	252

f. Reservoir Surface Area

	Acres
Test Flood (1/2 PMF)	36+
Top of Dam	36+
Recreation Pool	36
Spillway Crest	36

tory was obtained. Easement rights for the railroad were secured in 1851 and construction of the embankment was completed in 1855 or before, using glacial till. Reportedly some of the fill was placed during the winter using frozen soils. Within one year after construction the embankment was washed out, flooding North Bennington, and killing one person. Shortly thereafter the embankment was rebuilt.

In the early 1900's a spillway was constructed to form Lake Paran. Just prior to 1955 the spillway was reported to be composed of "timber planking containing a fill of loose stone." (See Report on Five Dams on Paran Creek, Appendix B.) In 1955 this old spillway was replaced with the existing concrete spillway.

Prior to 1955 there existed an old timber and concrete gate structure at the right (west) end of the embankment. The timbers were rotted at that time and in 1956 this gate was replaced with the existing structure.

i. Normal Operational Procedures

Normal operational procedures are not known. The gate at the right end of the embankment was not operable at the time of inspection.

1.3 Pertinent Data

a. Drainage Area

The drainage area above the dam consists of 15.6 square miles of rolling to mountainous terrain, with a maximum relief of 1,389 feet. The primary water course supplying Lake Paran is Paran Creek.

Soils within the drainage area range from the well-drained soils formed in glacial tills on limestone and slate uplands to soils formed in the sandy and gravelly fluvial deposits and the poorly-drained silty glacial-lacustrine deposits.

b. Discharge at Dam Site

(1) Outlet Works

Outlet works at Lake Paran consist of two structures, the spillway, described below, and a gated emergency drawdown structure on the right end of the dam. The emergency drawdown structure opens into a gated 4' x 5-1/2' box culvert with an invert elevation of ± 653.3 feet m.s.l., which is about 11.5 feet below the spillway crest. Downstream of the box culvert is a 4-foot diameter corrugated metal pipe outlet conduit.

c. Size Classification

The size classification of Lake Paran Dam would place it in the category of small. The height of the earth embankment is a maximum of 28-30 feet. The storage capacity with the lake level at the spillway crest (normal level) is 252 acre-feet; with the lake at top of dam the storage is approximately 350 acre-feet.

d. Hazard Classification

The potential for hazard in the event of failure of this dam is classified as high. It has been reported that the dam did fail in the 1850's. Many of the homes and mills along Paran Creek were destroyed and the death of a child resulted. Today approximately 25% of the Village of North Bennington is along this portion of Paran Creek. Most of the residential population and several industries would be endangered in the event of failure of this dam.

e. Ownership

Lake Paran is owned and operated by Paran Recreation, Inc., *North Bennington, Vermont.*

The railroad right-of-way has been turned over to the State of Vermont.

The ownership of the embankment itself is not known.

f. Operation

Lake Paran has no one individual responsible for the day to day operation of the dam or for periodic maintenance. The individual contacted to obtain Right of Entry was Mr. George Elwell, President, Paran Recreation, Inc., North Bennington, Vermont. Phone 802-447-7450.

g. Purpose of Dam

The impoundment is used for recreational purposes. Amenities provided by Paran Recreation, Inc. include the beach, a raft, public toilets, parking, lifeguards, etc. The embankment is used as a railroad right-of-way.

h. Design and Construction History

Based on verbal history obtained from Mr. Fred Welling, Chairman of the Board of Trustees, North Bennington, and Mr. George Bischoff of Vermont Railroads, the following construction his-

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
LAKE PARAN

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Authorization for the project was derived from The Dam Inspection Act, Public Law 92-367 which authorized the Secretary of the Army through the Corps of Engineers to initiate a program of safety inspection of dams throughout the United States. The work was performed under Contract No. DACW 33-78-C-0341 between the New England Division, Corps of Engineers and Dufresne-Henry Engineering Corporation, North Springfield, Vermont.

b. Purpose

The purpose of this inspection is to evaluate Lake Paran Dam and its appurtenant structures and to identify any conditons which jeopardize public safety.

This project will encourage and prepare the states to initiate effective dam safety programs. The project also provides for the verification and updating of the National Inventory of Dams.

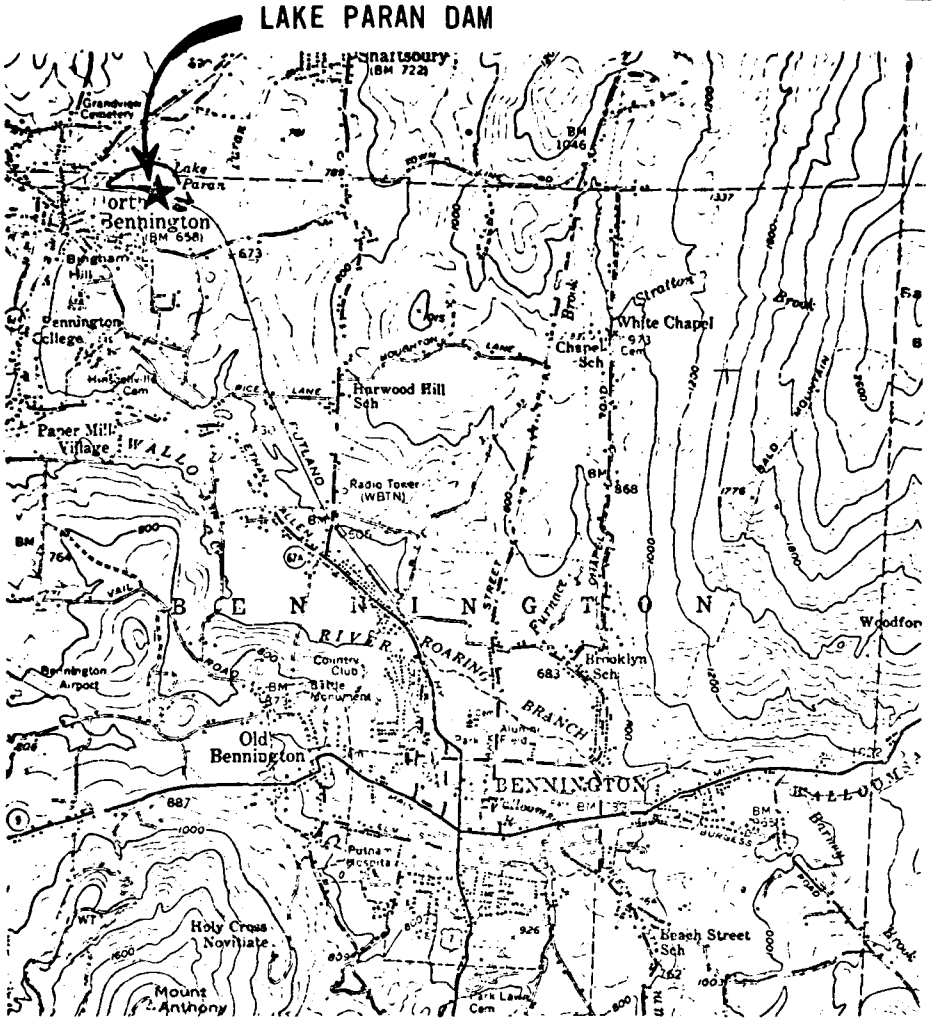
1.2 Description of Project

a. Location

Lake Paran Dam is located on Paran Creek in the Hudson River Basin in the Village of North Bennington, Bennington County in southwestern Vermont. The site is located approximately 1500 feet upstream from the Village of North Bennington and 1.7 miles from the confluence of Paran Creek and the Walloomsac River.

b. Description of Dam and Appurtenances

The embankment is 550 feet long and 29 feet high above the stream bed. The upstream slope is about 2.5H:1V and the downstream slope is abour 1.4H:1V. At the left end is a 90-foot long uncontrolled concrete spillway with a crest level about 3.3 feet below the top of the dam. At the right end there is a gate, with a 4-foot diameter outlet pipe, with the invert about 11.5 feet below the spillway crest and 14.8 feet below the top of the dam. At the left end of the embankment there is a railroad bridge over the spillway discharge channel.



SOURCE OF MAP:

U.S. GEOLOGICAL SURVEY
BENNINGTON QUADRANGLE,
VERMONT, 15 MIN. SERIES
1"=5280', 1954

CLIENT NO.	22-0551	DUFRESNE-HENRY ENGINEERING CORP.	
ENGINEER	MRP	LOCATION MAP	
DRAWN BY	LGF	LAKE PARAN DAM	
DATE	7-11-78	NORTH BENNINGTON VERMONT	A

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

Based on visual observations, this dam is in imminent danger of failing by internal erosion and subsequent collapse. There were no observations made that would indicate instability in the form of downstream sliding, slope failure or cracking.

b. Design and Construction Data

There are no such data available on which to base an evaluation of structural stability.

c. Operating Records

Operating records are nonexistent.

d. Post-construction Changes

See Section 1.2h.

e. Seismic Stability

The dam is in Seismic Zone 2, therefore no seismic analysis is required by the USCE Guidelines.

SECTION 7: ASSESSMENT, RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

This dam is in danger of failing if the lake is maintained at normal levels. Preliminary computations indicate a severe overtopping potential of the dam embankment. In the event of a test flood (1/2 PMF) a surcharge height of 3.3 feet above the top of the embankment would occur. The discharge from Lake Paran caused by either the test flood or failure of the dam is of greatest concern with respect to the other small dams downstream. Even in the event that Lake Paran did not fail during the test flood the discharge would severely endanger the small dams downstream. Failure of Lake Paran Dam would produce a flood wave 16 to 20 feet high.

Even though calculations are of a preliminary nature and accumulated information is limited, it becomes obvious that the spillway capacity does not meet the screening criteria set forth by the Corps of Engineers, and that a significant overtopping potential exists.

b. Adequacy of Information

The available information is not adequate to evaluate the stability of the dam against horizontal sliding, slope stability or cracking. In view of the large hole in the upstream face, failure by internal erosion is an immediate probability. However, since the character of the embankment itself is not known, one cannot judge how extensive a repair is needed to remove the danger of failure by internal erosion.

c. Urgency

The need was immediate to maintain a lake level low enough to essentially eliminate flow through the dam. Therefore, the recommendation was provided to the Corps of Engineers immediately.

d. Necessity for Additional Investigations

If it is desired to use this dam at normal lake levels, it must be redesigned and rebuilt.

7.2 Recommendations

The owner must engage an engineer to redesign and prepare contract drawings for reconstruction if the embankment is to be used as a dam.

Immediate consideration should be given to providing a means of increased spillway capacity. This is necessary due to the limited discharge capacity of the existing structure. The reservoir does not have sufficient storage to contain even a minor event without building a pool higher than the sink holes.

7.3 Remedial Measures

a. Alternatives

(1) To decrease the overtopping potential the following should be considered:

i. Significantly increase weir capacity to 1/2 PMF capacity.
ii. Provide adequate emergency drawdown structures.
iii. Provision to guarantee that flow through any bridge structure will not constrict flow.

(2) The dam may be abandoned if the lake is drained completely.

b. Operation and Maintenance Procedures

Due to the location of the dam upstream of a populated area, and the limited discharge capacity of the outlet works, round the clock surveillance should be provided during periods of unusually heavy precipitation. In addition the owner should develop a formal warning procedure with local officials for alerting downstream residents in case of emergency.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Lake Paran Dam

DATE June 22, 1978

TIME 11:00

WEATHER Mostly sunny, humid, 4-10 mph wind

W.S. ELEV._____ U.S.____ DN.S.

PARTY:

1. Walter Henry, D&H
2. Michael Peloso, D&H
3. Eric Slavin, D&H
4. Steve Poulos, GEI
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

PROJECT FEATURE	INSPECTED BY	REMARKS
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE PARAN DAM **DATE** June 22, 1978

PROJECT FEATURE _____ **NAME** _____

DISCIPLINE Geotechnical **NAME** S. J. Poulos

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	650.1 MSL
Current Pool Elevation	647.0 MSL
Maximum Impoundment to Date	650.1 MSL
Surface Cracks	None observed.
Pavement Condition	Railroad on crest. Apparently used by trains 8-10 times/week.
Movement or Settlement of Crest	None observed.
Lateral Movement	About 218 ft. rt. of rt. spillway wall th tracks are displaced ds slightly (~2 in.
Vertical Alignment	No vertical misalignment observed.
Horizontal Alignment	See "Lateral Movement"
Conditions at Abutment and at Concrete Structures	Considerable erosion around and below 4' diameter outlet structure. At upstream end, no erosion or misalignment observed.
Indications of Movement of Structural Items on Slopes	Sink holes due to erosion on left and right sides of spillway training walls, on u.s. side of embankment. 2 ft. diameter drain culvert above outlet structure, is in complete disrepair.
Trespassing on Slopes	Free access. Ties, strapping and miscellaneous trash dumped on d.s. slope.
Sloughing or Erosion of Slopes or Abutments	15 ft. to rt. of outlet structure there is a 3 to 4 ft. deep sinkhole directly over the 4 ft. dia. outlet pipe, just d.s. of d.s. crest line. A 6 ft. dia. hole exists about 265 ft. right of rt. wall of spillway. Decreases in dia. and accepts a fish line 25' long. Flow rate in 1000's gpm into hole. Whirlpool forms intermittently.
Rock Slope Protection - Riprap Failure	Riprap at water surface is discontinuous and slightly wave cut.
Unusual Movement or Cracking at or Near Toes	None observed.
Unusual Embankment or Downstream Seepage	100's or 1000's of gpm exiting from d.s. toe up to 2' above toe. Water was clear. Flow occurs at about 3 zones along toe 10 to 30 ft. long each.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE PARAN DAM **DATE** June 22, 1978

PROJECT FEATURE _____ **NAME** _____

DISCIPLINE Geotechnical **NAME** S. J. Poulos

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Piping or Boils	None observed.
Foundation Drainage Features	None apparent.
Toe Drains	None.
Instrumentation System	None.
Vegetation	Covered with trees and shrubs on d.s. slope.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE PARAN DAM DATE June 22, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE Geotechnical NAME S. J. Poulos

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	No dikes.
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE PARAN **DATE** June 22, 1978

PROJECT FEATURE **NAME**

DISCIPLINE Geotechnical **NAME** Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	Channel to outlet works almost completely filled in with lake bottom silt. A small V-notch channel exists through silt to gate, with max. depth 4 ft. below water surface. Weeds growing within.
Bottom Conditions	
Rock Slides or Falls	None.
Log Boom	None.
Debris	See above.
Condition of Concrete Lining	Horizontal crack in right abutment wall and misalignment.
Drains or Weep Holes	Not observable.
b. Intake Structure	
Condition of Concrete	Good
Stop Logs and Slots	Not applicable.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE PARAN DAM **DATE** June 22, 1978

PROJECT FEATURE **NAME** M. R. Peloso

DISCIPLINE Geotechnical **NAME** S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	None observed.
Visible Reinforcing	None observed.
Rusting or Staining of Concrete	None
Any Seepage or Efflorescence	None
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	Some seepage visible. Less than 1 gpm.
Cracks	Some minor cracks at joints.
Rusting or Corrosion of Steel	Some rusting of cog and gear wheel.
b. Mechanical and Electrical	
Air Vents	None
Float Wells	None
Crane Hoist	None
Elevator	None
Hydraulic System	None
Service Gates	Inoperable
Emergency Gates	None
Lightning Protection System	None
Emergency Power System	None
Wiring and Lighting System	None

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE PARAN DAM **DATE** June 22, 1978

PROJECT FEATURE _____ **NAME** _____

DISCIPLINE Geotechnical **NAME** S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	
Rust or Staining on Concrete	None apparent.
Spalling	None observed.
Erosion or Cavitation	None observed.
Cracking	None observed.
Alignment of Monoliths	Not applicable.
Alignment of Joints	Not applicable.
Numbering of Monoliths	Not applicable.

Note:

Conduit is of stone masonry construction and alignment and condition appears to be very good.

Conduit changes direction and a 48" diameter C.M.P. is used to cross under the railroad embankment.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE PARAN DAM **DATE** June 22, 1978

PROJECT FEATURE **NAME** Peloso

DISCIPLINE Geotechnical **NAME** S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Walls are fair; apron is poor.
Rust or Staining	None.
Spalling	Serious spalling
Erosion or Cavitation	And erosion on concrete apron.
Visible Reinforcing	None
Any Seepage or Efflorescence	None
Condition at Joints	Not observed.
Drain Holes	None observed.
Channel	
Loose Rock or Trees Overhanging Channel	Completely cluttered with trees and broken portions of structure. Channel slopes are eroded.
Condition of Discharge Channel	Poor
	Note: Serious erosion at apron where discharging water drops vertically and flows underground 15' before it exits to the channel.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE PARAN DAM DATE June 22, 1978

PROJECT FEATURE NAME M. R. Peloso

DISCIPLINE Geotechnical NAME S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Not observable, underwater.
Loose Rock Overhanging Channel	None
Trees Overhanning Channel	None
Floor or Approach Channel	Not observable, underwater.
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None
Spalling	None
Any Visible Reinforcing	None
Any Seepage or Efflorescence	Several seeps from walls of training walls downstream of weir, one flowing.
Drain Holes	None evident.
c. Discharge Channel	
General Condition	Fair
Loose Rock Overhanging Channel	Some loose stones in walls may become dislodged.
Trees Overhanging Channel	Much shrubbery and trees up to 2 feet size.
Floor of Channel	Good condition.
Other Obstructions	A few railroad ties lie in channel

PERIODIC INSPECTION CHECK LIST 10 of 10

PROJECT LAKE PARAN DAM DATE June 22, 1978

PROJECT FEATURE NAME

DISCIPLINE Geotechnical NAME S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	Not Applicable
a. Super Structure Bearings Anchor Bolts Bridge Seat Longitudinal Members Under Side of Deck Secondary Bracing Deck Drainage System Railings Expansion Joints Paint	Note: Railroad bridge crosses the channel. Training walls of channel are abutments for bridge
b. Abutment & Piers General Condition of Concrete Alignment of Abutment Approach to Bridge Condition of Seat & Backwall	

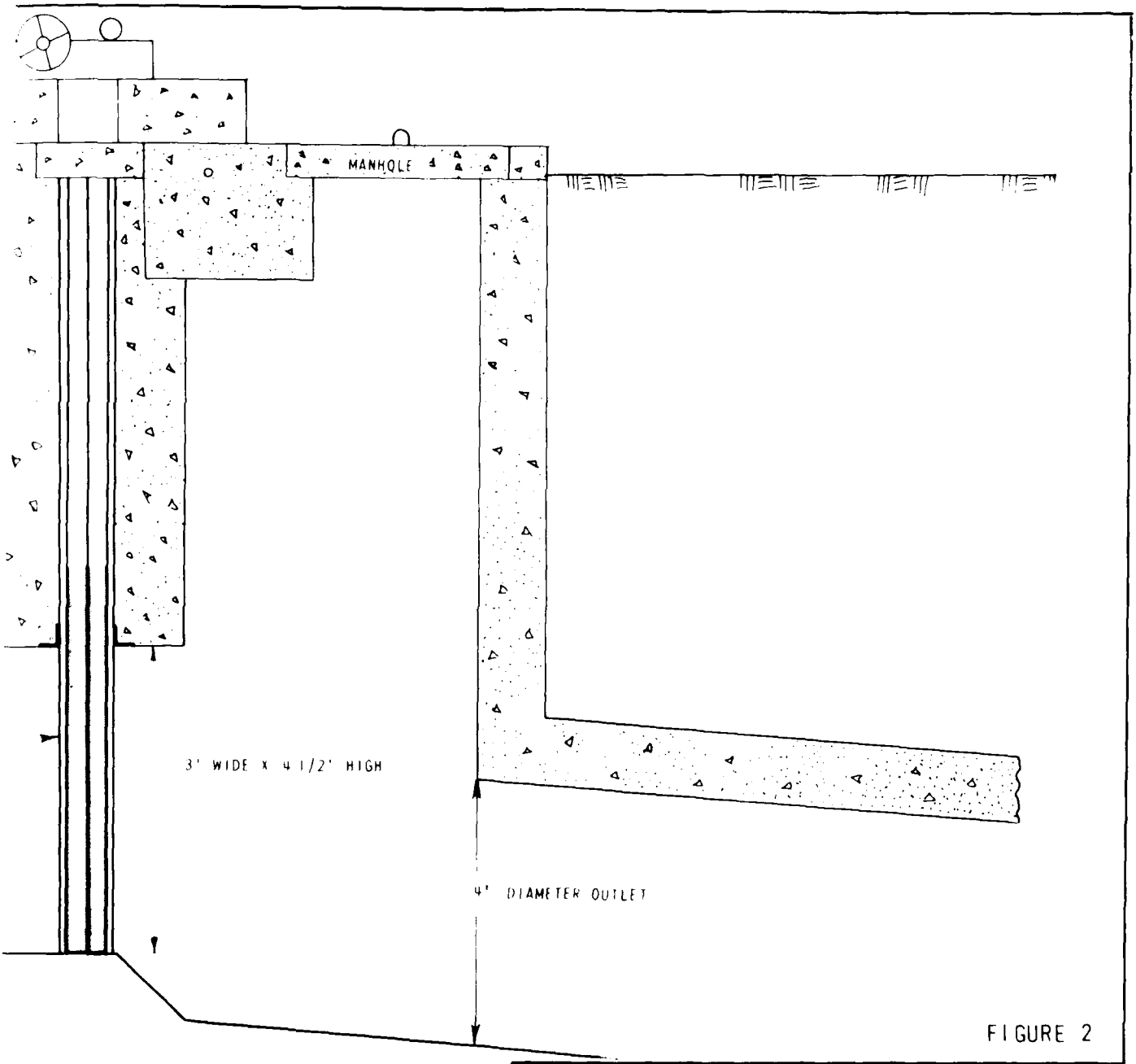


FIGURE 2

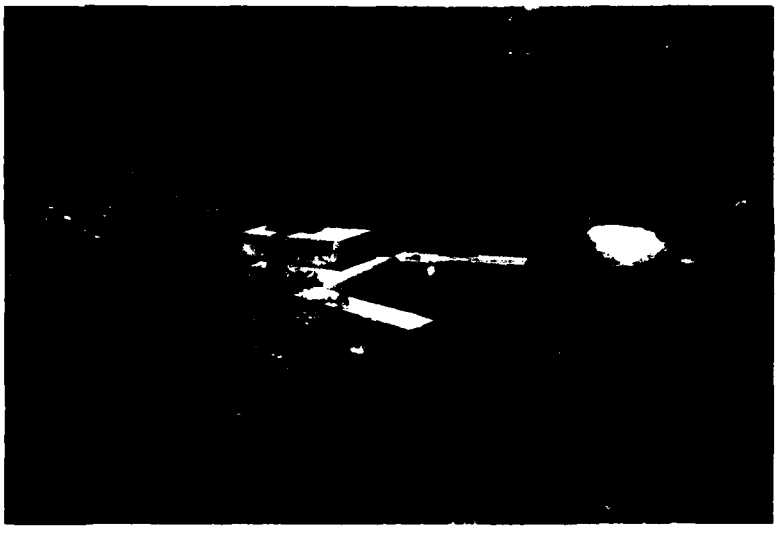
DUFRESNE-HENRY ENGINEERING CORP. ARCHITECT-ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE PARAN DAM

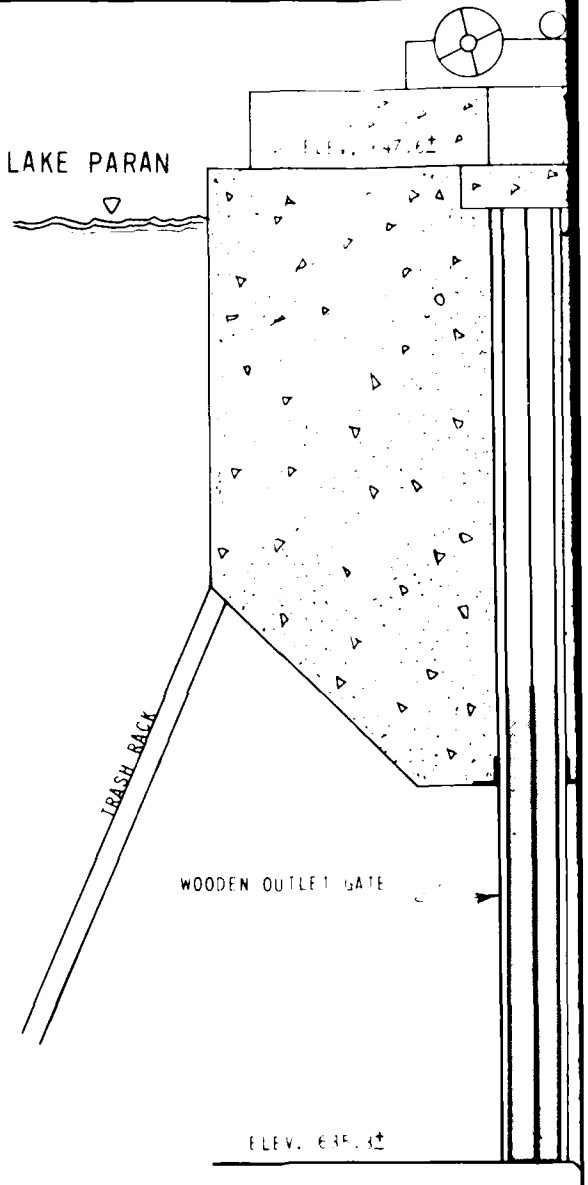
NORTH BENNINGTON VERMONT

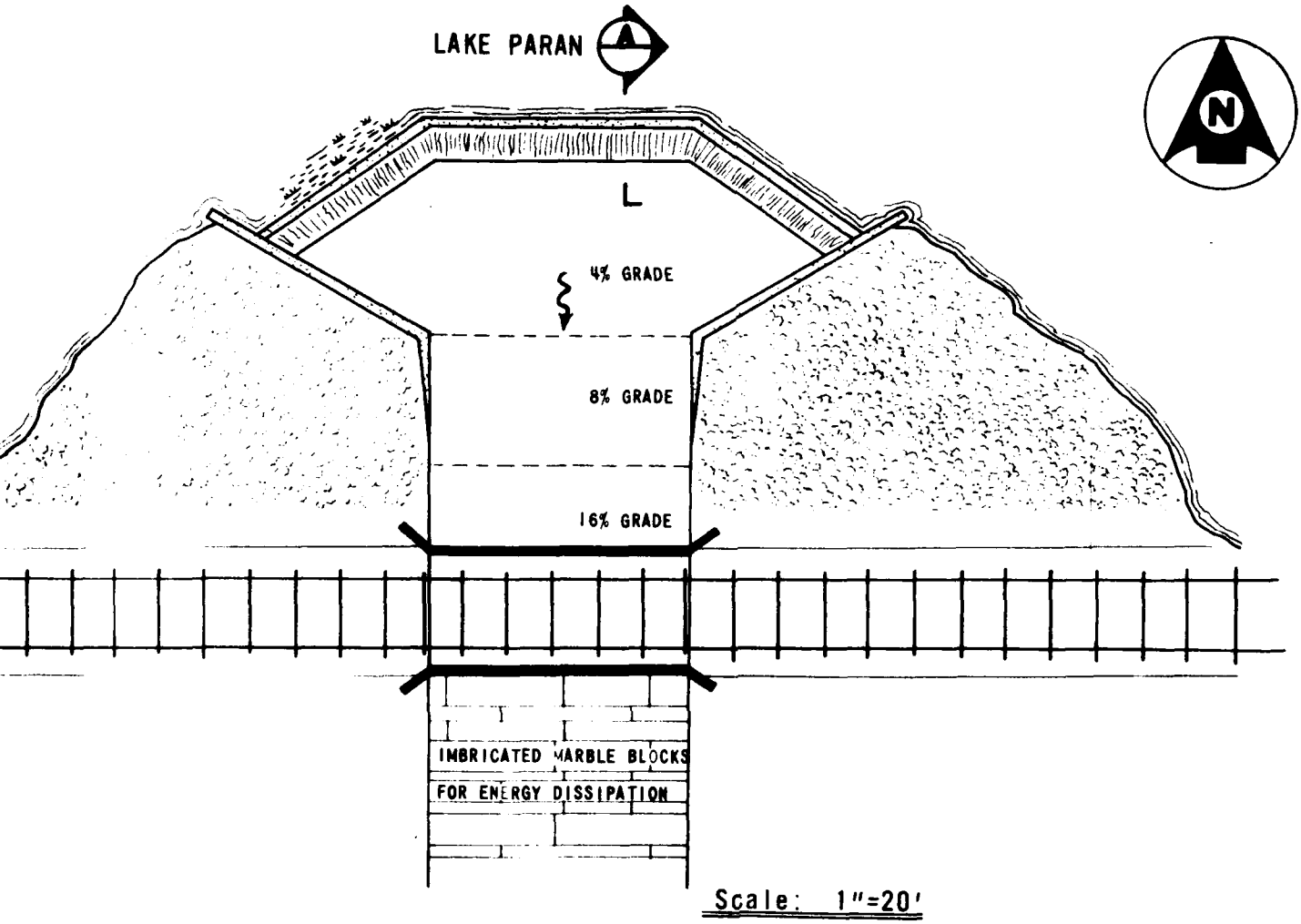
C.N.	22-0551		SCALE JULY 1978
			DATE



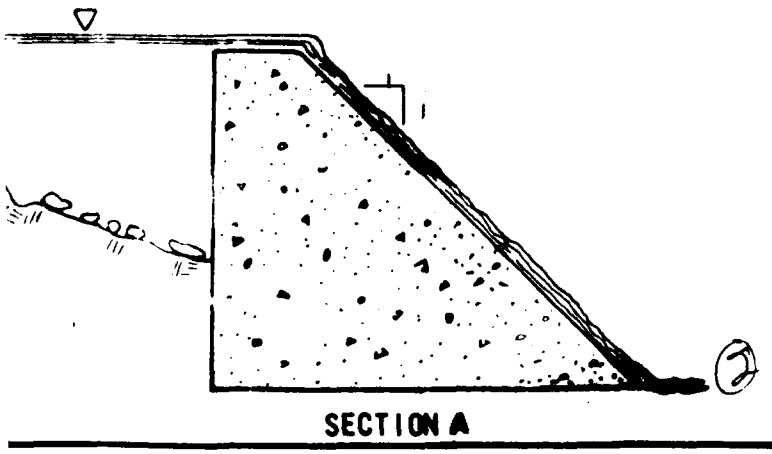
VIEW OF OUTLET STRUCTURE FROM RAILROAD EMBANKMENT

INDICATION OF DEBRIS BUILD UP IN FRONT OF TRASH RACK AT OUTLET STRUCTURE





Scale: 1"=20'



SECTION A

FIGURE 1

DUFRESNE-HENRY ENGINEERING CORP. ARCHITECT-ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

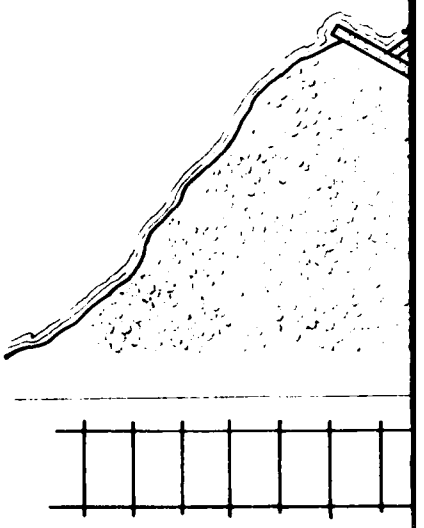
LAKE PARAN DAM

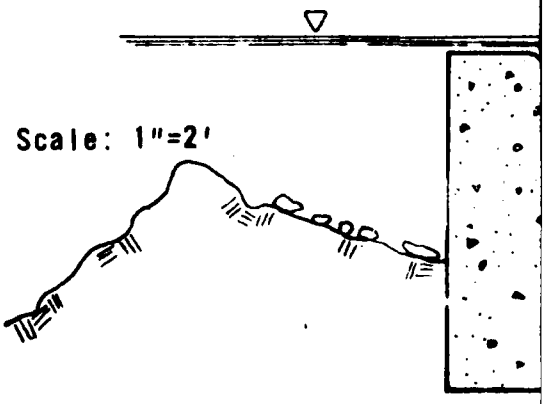
NORTH BENNINGTON VERMONT

C.N.	22-0551		SCALE
			DATE

VIEW OF SPILLWAY FROM THE LEFT TRAINING WALL

DISCHARGE CHANNEL LOOKING UPSTREAM





LAKE PARAN

On Dec. 8, 1955 the undersigned visited Lake Paran to view the new construction on the spillway and the outlet gate. Mr. Welling, the Treasurer at the Stark Paper Co., who owns the dam, was also along on the visit.

The new construction on the spillway section is practically complete. The spillway section of the dam is made up of timber planking over stone fill. The planking and timbers were old and rotting so that water was leaking thru it. The old timber and loose rocks have been removed and replaced with concrete. The overflow crest is 90 feet long and is built in a semi hexigon fashion. The upstream face is vertical, a crest width of 1 foot and a downstream slope of approx. 45^0 . This then leads to a chute some 4 feet lower than the crest. The chute is some 40 feet wide leading to a bridge under the railroad. The railroad fill makes up the rest of the dam. It is approx. 4 feet higher than the crest of the spillway.

At the West side of the fill isan old gate structure. It was built of timber and concrete, but the timbers are all rotted away. Mr. Welling plans on constructing a new gate structure as soon as he has finished the spillway.

Lake Paran has a drainage area of 15 square miles and flows 36 acres. The reservoir is presently used for recreation.

The construction at the dam appears very good and should last for a great many years.

Mr. Welling will send us a sketch of the gate structure as soon as they decide what should be put in for the new structure.

JOHN E. CERUTTI
WATER CONSERVATION BOARD
Dec. 8, 1955

INSPECTION REPORT
ON
Lake Paran Dam

1. Date of inspection 4/10/52 2. Water conditions overflowing pond

GENERAL DATA:

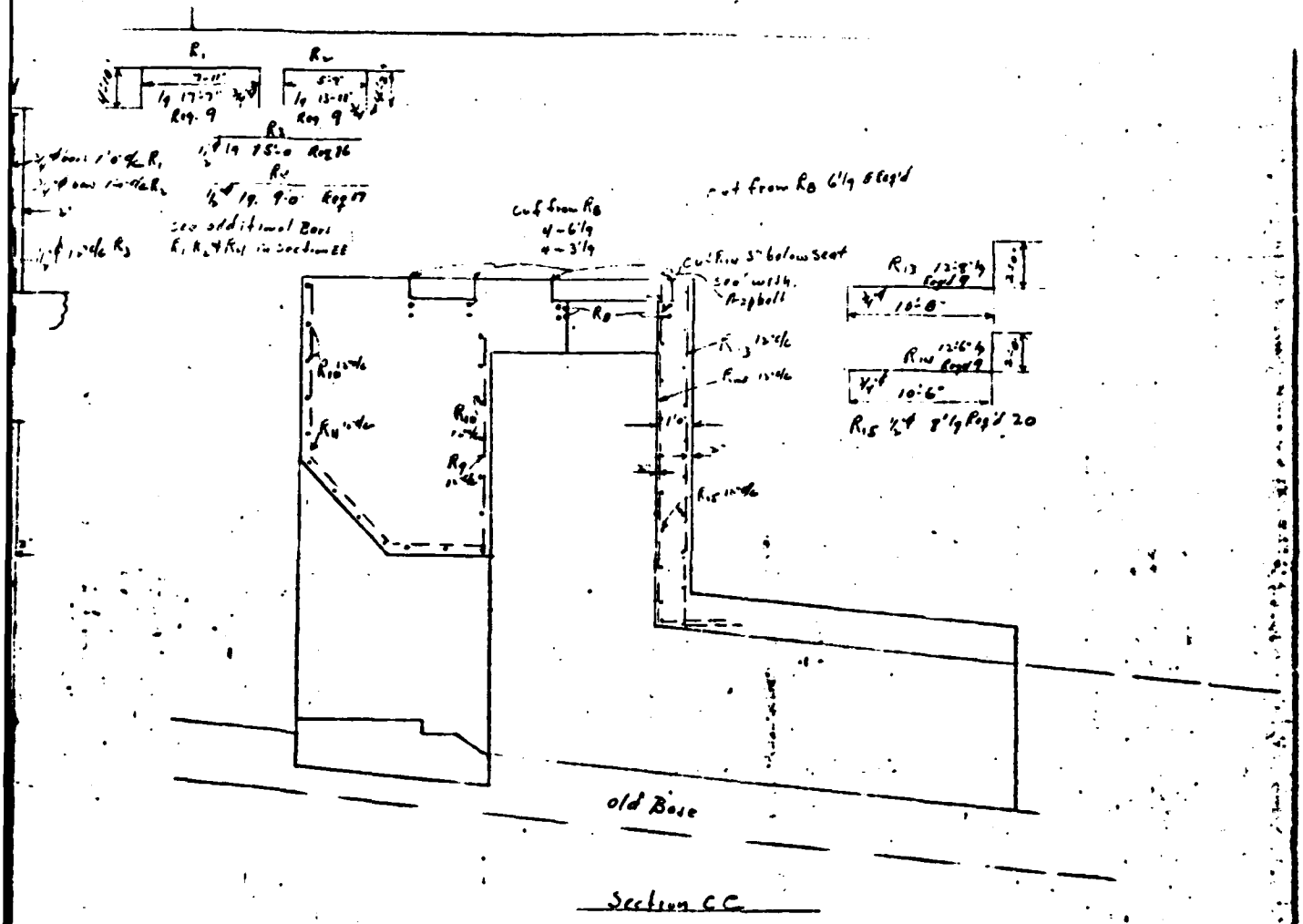
3. Location of dam Paran Cr, N. Bennington.
4. Owner and operator
5. Characteristic features of dam embankment supporting a railroad, timber-lined chute spillway
6. Other related data (see writer's previous report

OBSERVATIONS:

7. Condition of structure Embankment - perceptible seepage at toe along east half - fill remains stable; Spillway - some of the rotted timber planking have been removed by action of water; Sluceway - crowded with debris.
8. Condition of equipment none
9. Operation none
10. Maintenance embankment weed growth under control common with RR right of way

REMARKS:

Inspected by SHH



Section C C

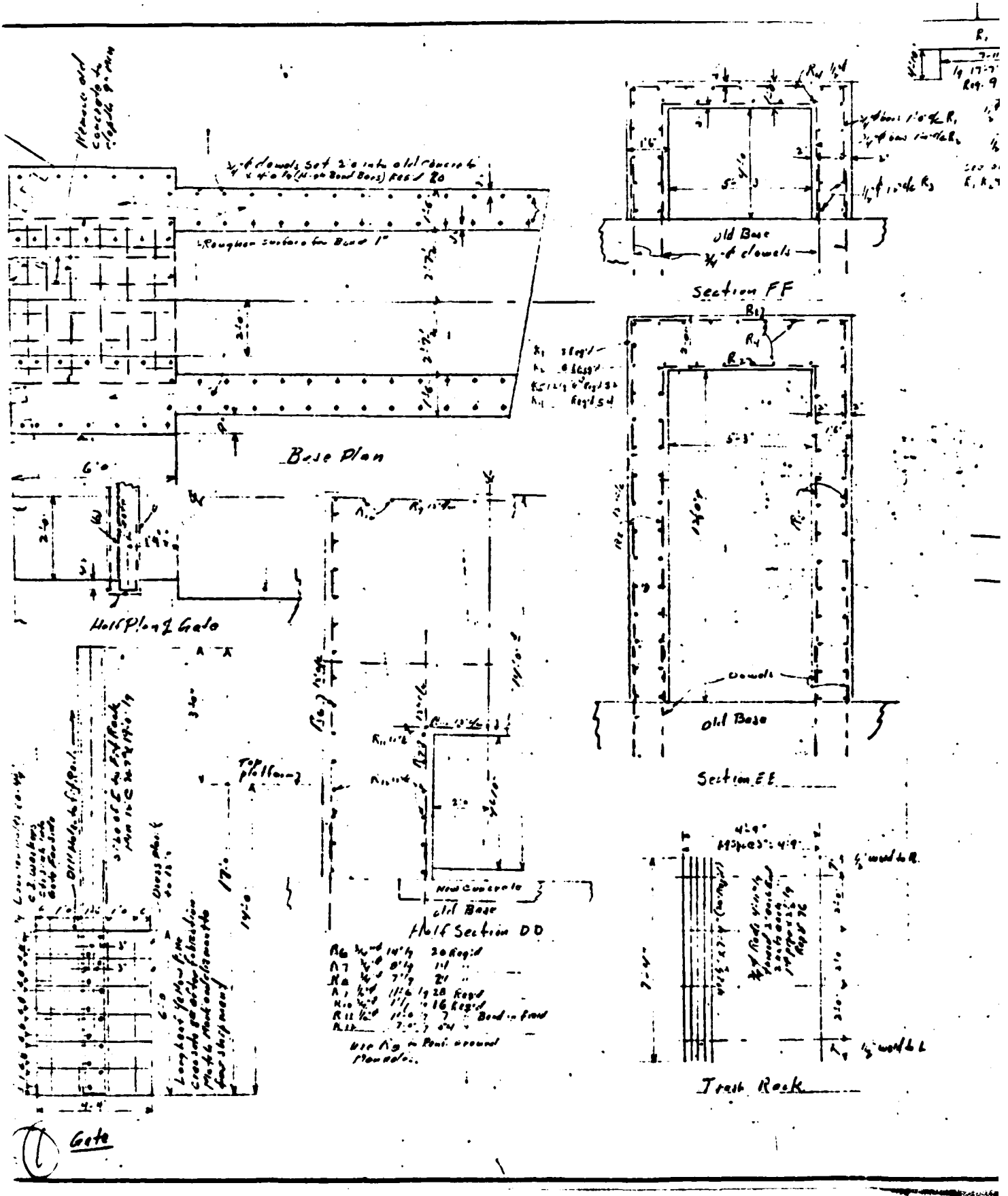
Steel Steel / Rein Steel details to be checked by Supplier.

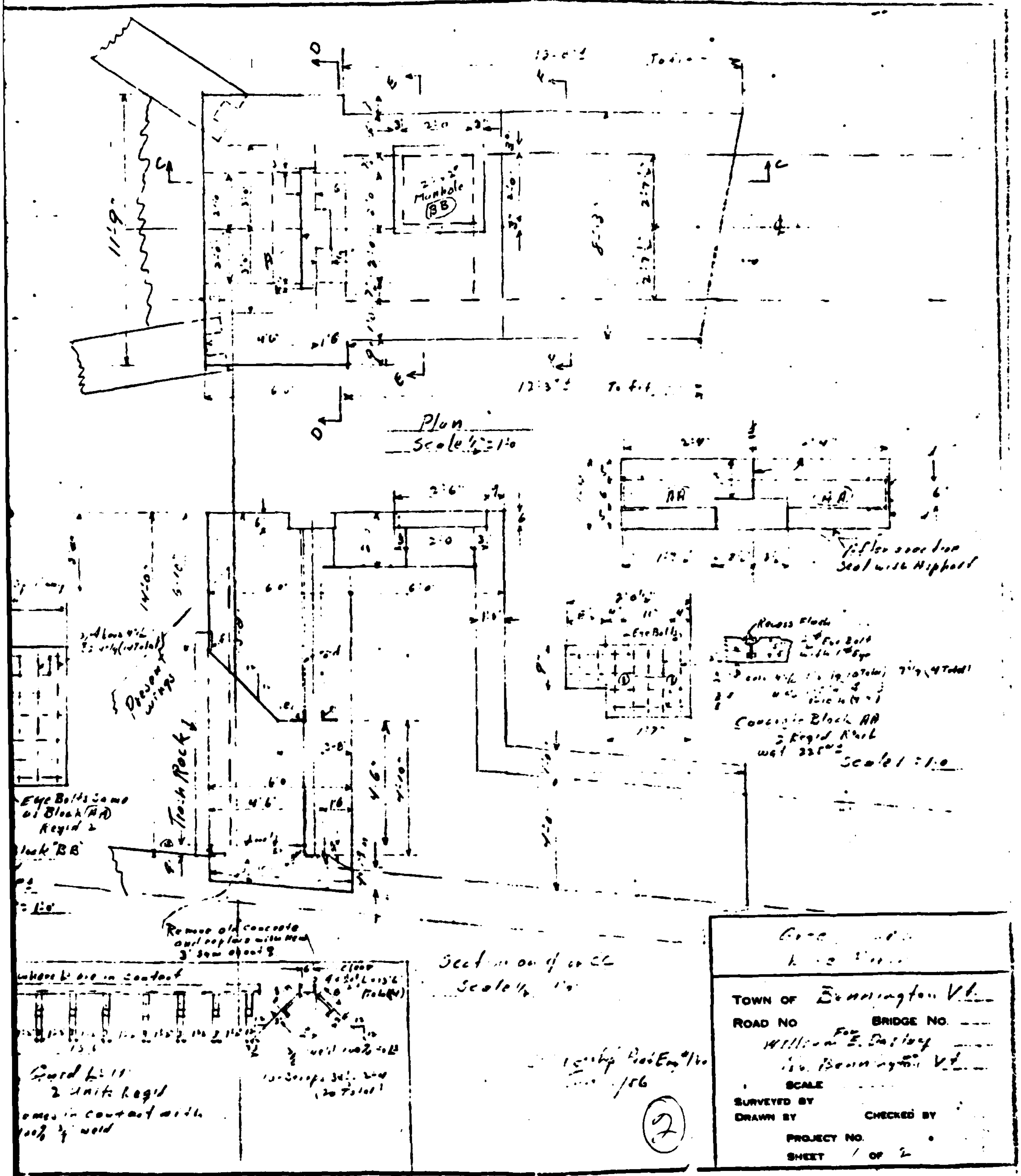
Gage Detail
Lake Paran

TOWN OF Bennington Vt
ROAD NO. ___ To ___ BRIDGE NO. ___
William E Dailey
No Bennington Vt
SCALE 1/2 = 1'-0"
SURVEYED BY ___
DRAWN BY ___ CHECKED BY ___
PROJECT NO. ___
SHEET 2 OF 2

O.K. Rudolf P.E. Vt
Jan 16/56

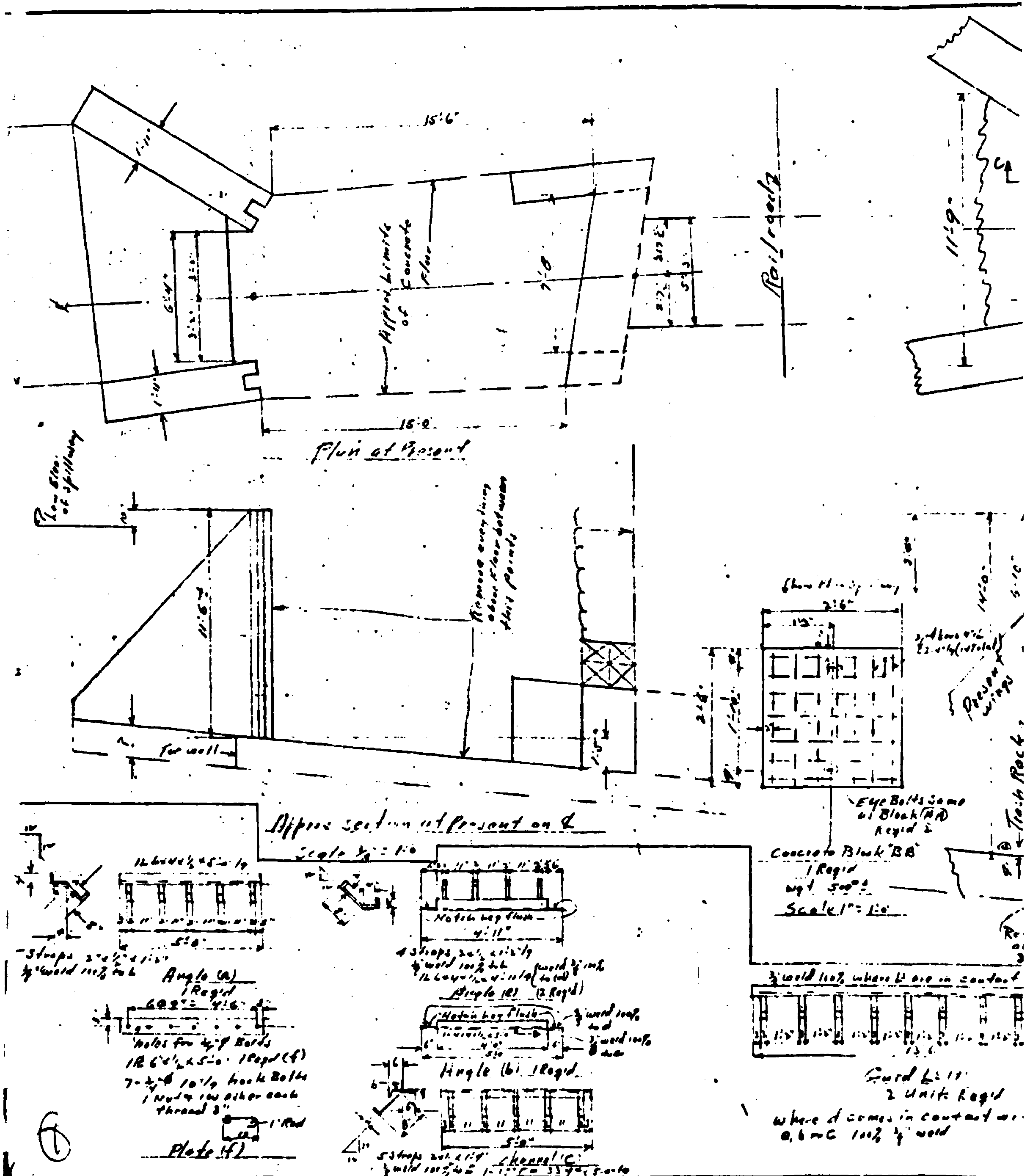
(2)


Base Plan
Half Plan & Gate
Section FF
Old Base
Section EE
Old Base
Dowels
Half Section DD
New Concrete
Old Base
Trash Rack
Gate



TOWN OF Bennington Vt.
ROAD NO BRIDGE NO.
For William E. Dailey [?]
No. Bennington Vt.
SCALE
SURVEYED BY
DRAWN BY CHECKED BY
PROJECT NO.
SHEET 1 OF 2

(2)



15'6"
Railroad
Approx. Limits of Concrete Floor
7'0"
6'4"
1'11"
11'9"
15'0"
Plan at Present
Remove everything above floor between this points
11'6"
Tie wall
2'6"
Eye Bolts same as Block (AA) Req'd 2
Concrete Block "BB"
1 Req'd
wgt 500#
Scale 1" = 1'0"
Present wings
Approx section at Present on ℄
Scale 1/4" = 1'0"
Notch bay flush
4'11"
5'0"
Angle (A)
1 Req'd
Angle (b) 1 Req'd
Plate (f)
Channel (C)
Guard L's
2 Units Req'd

6

At the west end is an outlet structure, formerly used for regulated discharge from the lake. It now exists with old abandoned timber intake works and gate, and a 4 foot diameter corrugated metal culvert through the embankment.

Remarks - Since the dam is no longer used for the purpose originally intended, it has been left with no maintenence except for what is secondary from the upkeep given to the railroad right-of-way along the embankment.

The timbers in both the spillway and the outlet structure are in bad decay. As a result, excessive leakage occurs, particularly so in the spillway section where it passes through the stone fill under the planking. However, this leakage is where it cannot do serious harm to the embankment. The concrete and masonry portions of these outlet structures and the metal culvert pipe are in good condition.

Some water was noticed in the ditch at the downstream toe of the dam. This could be seepage through the embankment or it could be area drainage or both. From casual observation the embankment appeared in a stable condition. Ample section for stability is indicated.

Concluding - Lake Paran dam is the most important of this group of dams. Properly manipulated, it can serve as a flood control structure because of its storage potential which may reduce the flood peak in Paran Creek between 40 and 50 percent.

The timber portion of the spillway should be repaired, preferably replaced with a more water-tight section. For the conduit at the west end of the dam, improvements should be such as to provide free discharge at the higher pond levels and thus augment the spillway which can just about handle a flood of past record size.

Lake Paran Dam

Layout - Lake Paran is created by a high earth embankment which also serves as the right-of-way for the Bennington Branch of the Rutland Railroad. This embankment (about 500 feet long) has an average top width of 23 feet and a maximum depth between 25 and 30 feet. Its downstream face has a slope of about 1 on 2 or flatter. The upstream slope about 1 on 1 and its upstream face has a sparse cover of large boulders while the downstream face is overgrown with wild grass.

At the east end of the embankment is a spillway chute. The overflow crest for this chute is shown in Figure 1. This crest, built in a semi-hexagon fashion, has a total length of about 75 feet and is 4 feet below the top of the dam. Its section is made up of timber planking containing a fill of loose stone. It has a crest width of 1 foot, a vertical upstream face, and a sloping downstream face of about 45°. The chute is a sloped rectangular channel, 35 feet wide, beginning about 4 feet lower in elevation than the crest. It has concrete sides, and a bottom of timber planks in the upper portions and hand-placed stone in the lower portions. A steel girder bridge over the channel provides for the railroad crossing.

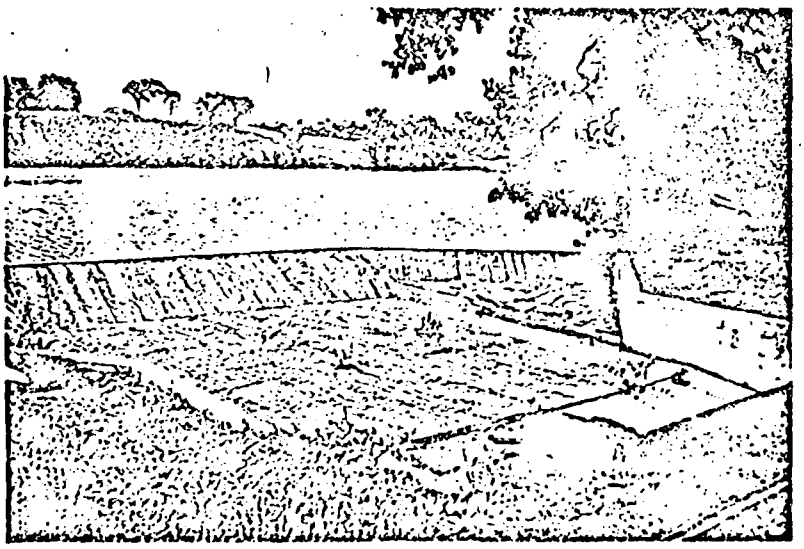


Fig. 1 Timber portion of chute spillway, Lake Paran dam

STATE OF VERMONT
WATER CONSERVATION BOARD
MONTPELIER

REPORT ON FIVE DAMS ON PARAN CREEK

IN

BENNINGTON, VERMONT

The only dams of jurisdictional size in the town of Bennington are the five dams located on Paran Creek in the vicinity of the village of North Bennington. These were examined by the writer last July and their condition noted herein.

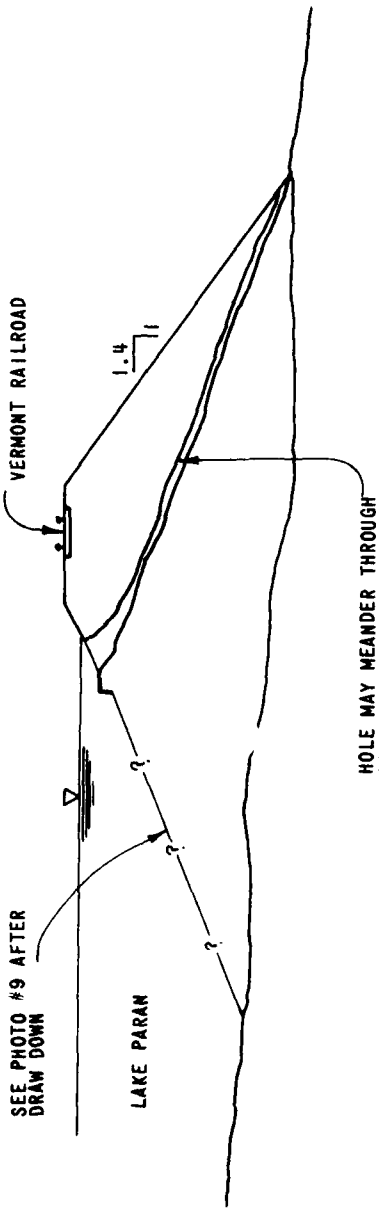
Summary of Pertinent data

Qualifying data on each dam is given below in the order of its location in the course of the stream.

Designation	Owner of dam	Present use of dam	Size of Pond: Surface area in acres	Size of Pond: volume in cu. ft.	Drainage Area in sq. mi.
Lake Paran	Stark Paper Co. & Rutland R.R.	Recreation	36	11,000,000	15
White's Mill	Ed White	(not in use)	3	500,000	15
Stark Mill	Stark Paper Co. (D. Welling) owner	(not in use)	2	500,000	15
Cushman	H.D. Cushman Mfg. Co.	Augments a steam plant in private power generation	4	800,000	16
Polygraphic	Polygraphic Co. of America	Minor use for water supply for fire protection	4	500,000	17

APPENDIX B

1. Data is unavailable pertaining to design, construction and maintenance.
2. Copies of past inspection reports.
3. Plans showing layout of dam sections details of various features.

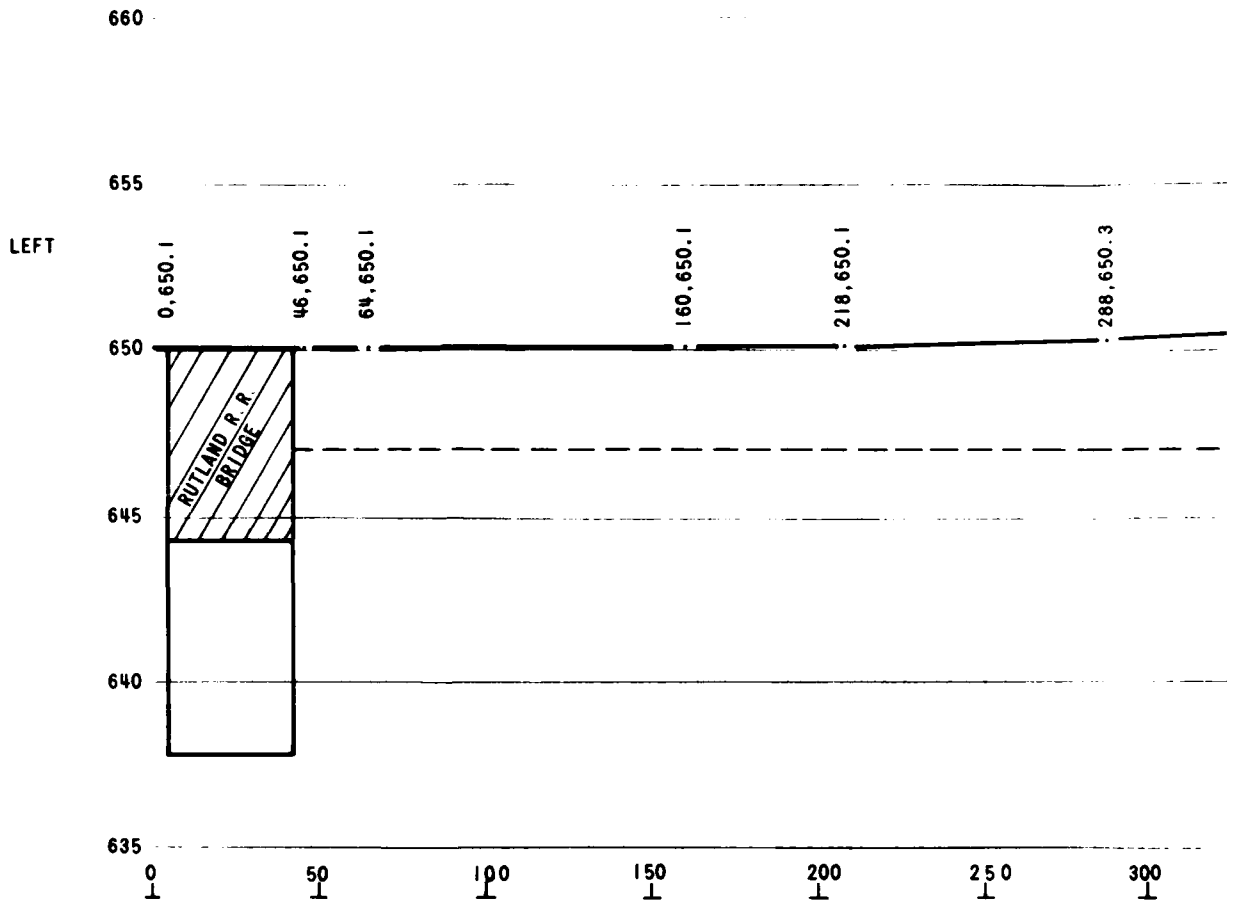


ESTIMATED CROSS SECTION

1"=25' APPROX.

CONSTRUCTED 1852

CLIENT NO	22-0551	DUFRESNE-HENRY ENGINEERING CORP.	FIGURE 3
ENGINEER	MRP	LAKE PARAN DAM	
DRAWN BY	RB		
DATE	6-25-76	NORTH BENNINGTON VERMONT	A


660
655
LEFT
0,650.1
46,650.1
64,650.1
160,650.1
218,650.1
288,650.3
650
RUTLAND R.R. BRIDGE
645
640
635
0
50
100
150
200
250
300

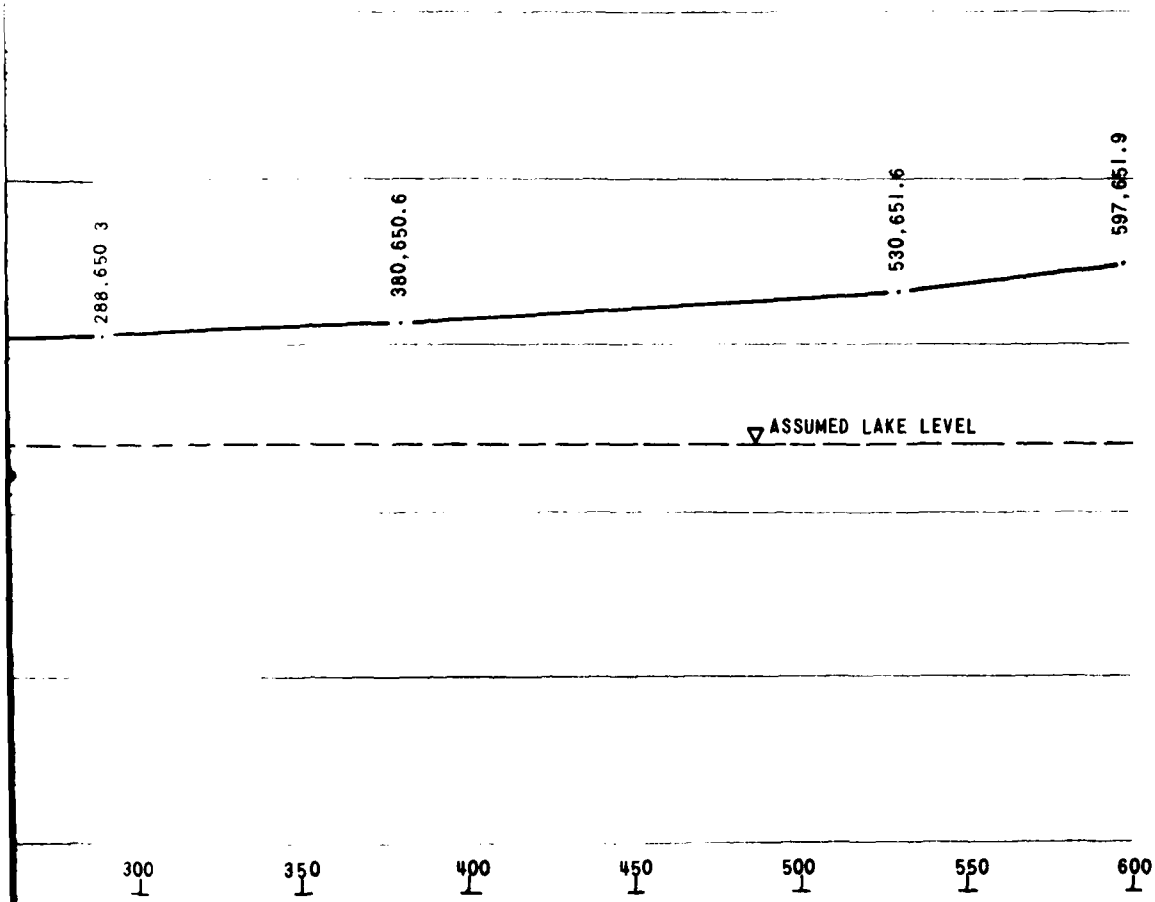


FIGURE 4

DUFRESNE-HENRY ENGINEERING CORP. ARCHITECT-ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE PARAN DAM
TOP OF DAM PROFILE

(2)

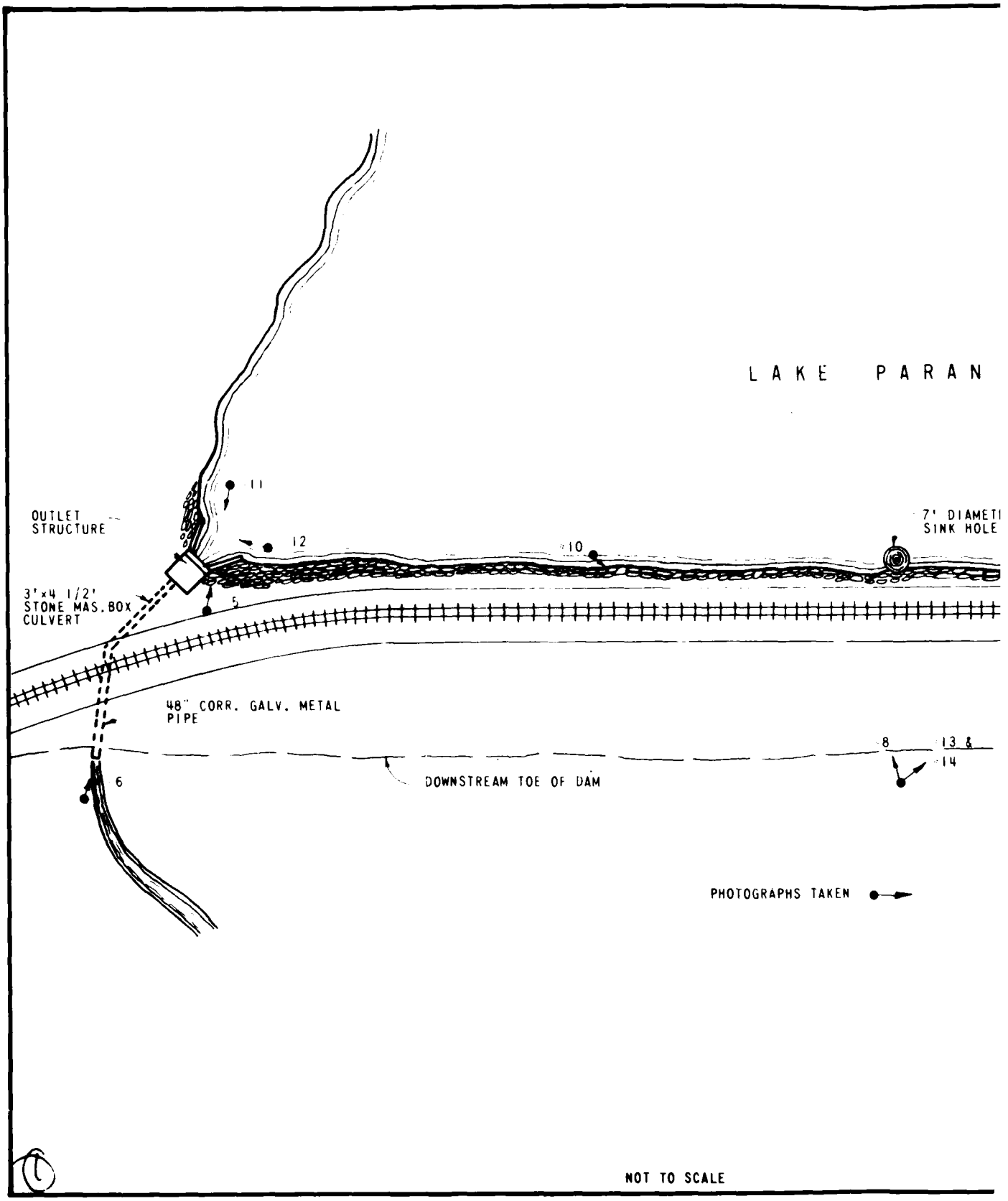
NORTH BENNINGTON VERMONT

DRAWN	RB		SCALE 1"=20' HOR. AND VERT.
ENGR.	MRP		DATE JULY 19, 1978

APPENDIX C

PHOTOGRAPHS

1. Upstream face of dam, looking west from spillway.
2. Downstream face of dam, looking west from railroad bridge.
3. Leakage in stone masonry right abutment/training wall, 2 feet from end of concrete wall.
4. Crack in right abutment of spillway training wall.
5. Outlet structure at west end of impoundment.
6. Outlet tube 4' diameter which passed below railroad embankment.
7. Looking west from railroad bridge, track alignment is offset at location of sinkhole.
8. The volume of flow indicated in this photograph is typical of a 30' long section at the toe of slope.
9. Upstream face of dam, looking west from spillway, sinkhole was located at mound of gravel.
10. Approximately 100' west of the large sinkhole another was starting to form.
11. Outlet structure at west end of dam, a portion of the debris removed can be seen in the upper left hand corner.
12. Crack in right abutment wall of outlet structure, wall has a vertical misalignment of 2".
13. Reduction of flow as a result of filling the sink hole with cobbles and gravel.
14. Flow has completely stopped in this section as a result of lowering the pool 4'.


LAKE PARAN
OUTLET STRUCTURE
11
12
10
7' DIAMETI
SINK HOLE
3'x4 1/2' STONE MAS. BOX CULVERT
5
48" CORR. GALV. METAL PIPE
8
13 &
14
6
DOWNSTREAM TOE OF DAM
PHOTOGRAPHS TAKEN
NOT TO SCALE

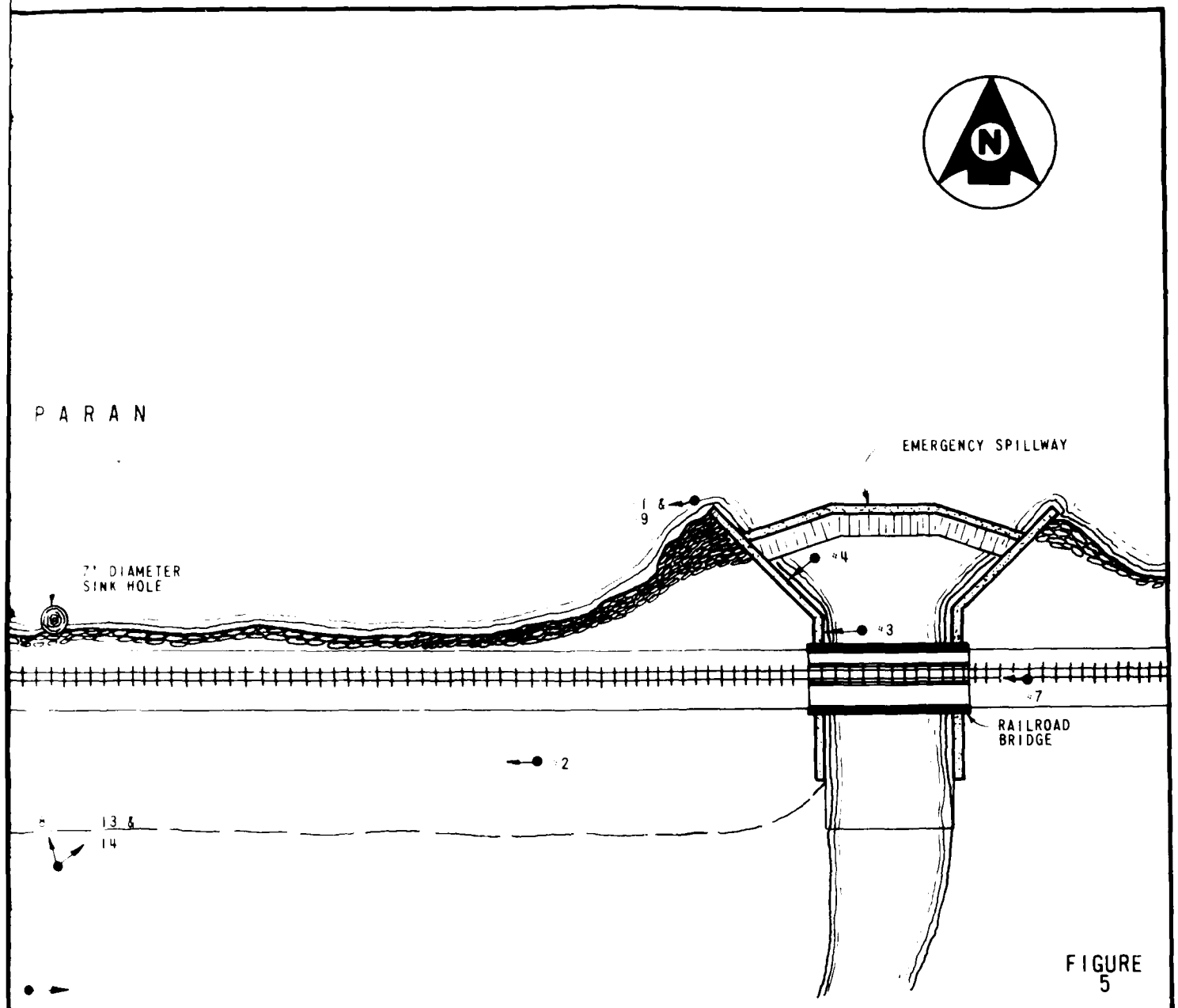


FIGURE 5

DUFRESNE-HENRY ENGINEERING CORP. ARCH TECT-ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCATIONS OF PHOTOGRAPHS
TAKEN 6/22, 6/26 & 7/3/1978

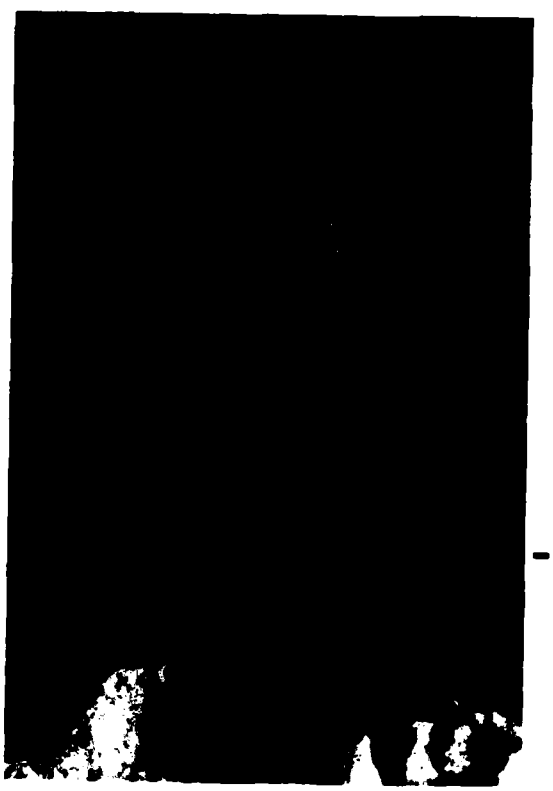
NO. BENNINGTON VERMONT

22-055	ENG.	MP	SCALE
			DATE

#1 UPSTREAM FACE OF DAM LOOKING WEST FROM SPILLWAY

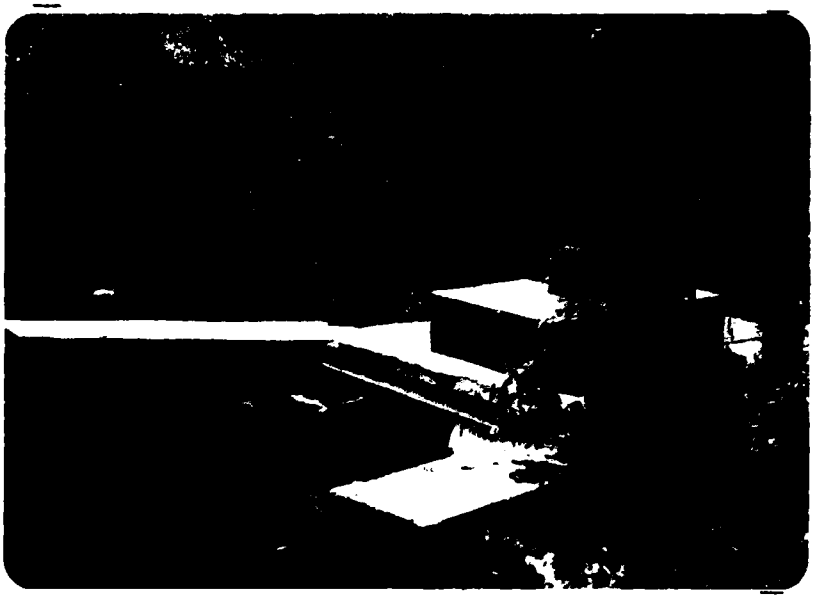
#2 DOWNSTREAM FACE OF DAM LOOKING WEST FROM RAILROAD BRIDGE

#3 LEAKAGE IN STONE MASONRY RIGHT ABUTMENT/TRAINING WALL, 2 FEET FROM END OF CONCRETE WALL

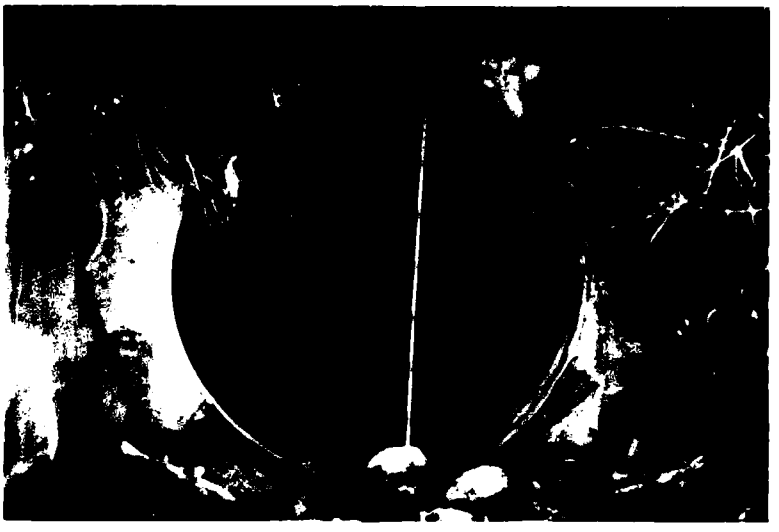


#4

CRACK IN RIGHT ABUTMENT OF SPILLWAY TRAINING WALL



#5 OUTLET STRUCTURE AT WEST END OF IMPOUNDMENT



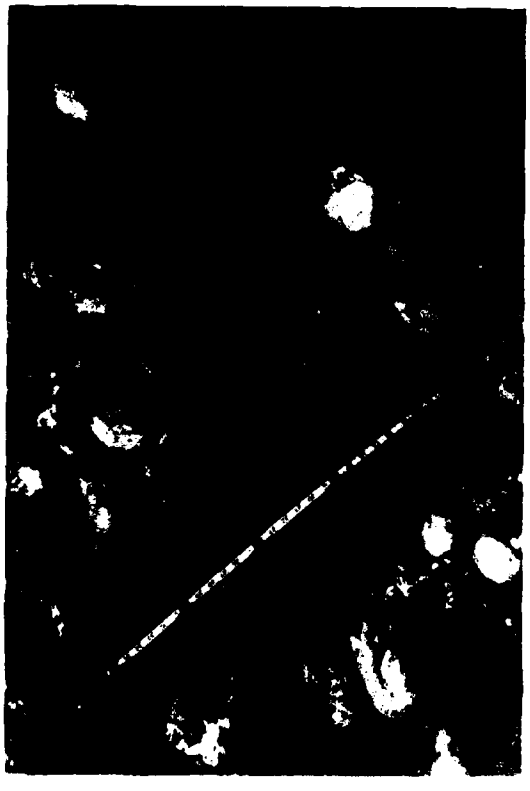
#6 OUTLET TUBE 4' DIAMETER WHICH PASSED BELOW RAILROAD EMBANKMENT

#7 LOOKING WEST FROM RAILROAD BRIDGE TRACK ALIGNMENT IS OFFSET AT LOCATION OF SINK HOLE.

#8 THE VOLUME OF FLOW INDICATED IN THE PHOTOGRAPH IS TYPICAL OF A 30' LONG SECTION AT THE TOE OF SLOPE.

PHOTOGRAPHS OF LAKE PARAN AFTER POOL WAS LOWERED 4' JULY 3, 1978.

#9 UPSTREAM FACE OF DAM LOOKING WEST FROM SPILLWAY, SINK HOLE WAS LOCATED AT MOUND OF GRAVEL



#10

APPROXIMATELY 100' WEST OF THE LARGE SINK HOLE ANOTHER WAS STARTING TO FORM.

#11 OUTLET STRUCTURE AT WEST END OF DAM, A PORTION OF THE DEBRIS REMOVED CAN BE SEEN IN THE UPPER LEFT HAND CORNER.

#12 CRACK IN RIGHT ABUTMENT WALL OF OUTLET STRUCTURE, WALL HAS A VERTICAL MISALIGNMENT OF 2".

#13 REDUCTION OF FLOW AS A RESULT OF FILLING THE SINK HOLE WITH COBBLES AND GRAVEL

#14 FLOW HAS COMPLETELY STOPPED IN THIS SECTION AS A RESULT OF LOWERING THE POOL 4'.

APPENDIX D

HYDRAULIC COMPUTATIONS

1. Hydrologic Computations.

2. Outline of drainage area and affected downstream areas.

STATION 1

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

		0.	4000.	8000.	12000.	16000.	20000.	24000.	28000.	0.	0.	0.	0.
		0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	PRECIP(*) AND EXC 2.	1.
1		301											
1		601											
1		301											
1	1	601											
1	2	301											
1		601											
1		301											
1		601											
1	4	301											
1	4	601											
1	5	301											
1		601											
1		301											
1	6	601											
1	7	301											
1	7	601											
1		301											
1		601											
1		301											
1	9	601											
1	10	301											
1		601											
1		301											
1		601											
1	12	301											
1	12	601											
1		301											
1		601											
1		301											
1	14	601											
1	15	301											
1		601											
1		30.1											
1		60.1											
1	17	30.1											
1	17	60.1											
1	8	30.1											
1	8	60.1											
1	9	30.1											
1	19	60.1											
1	20	30.1											
1	0	60.1											
1	1	30.1											
1	1	60.1											
1	22	30.1											
1	22	60.1											
1	23	301											
1	3	601											
2	0	301											
2	0	601											
2	1	301											
2	1	601											
2	2	301											
2	2	601											

3 22 60	0.00	0.00	174.
3 23 30	0.00	0.00	171.
3 23 60	0.00	0.00	169.
SUM	20.60	15.74	338228.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	25292.	19100.	6664.	2349.	338229.
INCHES		11.39	15.90	16.81	16.81
AC-FT		9476.	13226.	13984.	13984.

2	13	60	0.93	0.00	3729.
2	14	30	1.17	1.09	5236.
2	14	60	1.17	1.09	7063.
2	15	30	2.95	2.88	9332.
2	15	60	2.95	2.88	12279.
2	16	30	1.09	1.01	15734.
2	16	60	1.09	1.01	19253.
2	17	30	0.86	0.78	22340.
2	17	60	0.86	0.78	24478.
2	18	30	0.08	0.01	25292.
2	18	60	0.08	0.01	24557.
2	19	30	0.08	0.01	22510.
2	19	60	0.08	0.01	19854.
2	20	30	0.08	0.01	17030.
2	20	60	0.08	0.01	14232.
2	21	30	0.08	0.01	11649.
2	21	60	0.08	0.01	9449.
2	22	30	0.08	0.01	7674.
2	22	60	0.08	0.01	6243.
2	23	30	0.08	0.01	5089.
2	23	60	0.08	0.01	4157.
3	0	30	0.00	0.00	3405.
3	0	60	0.00	0.00	2796.
3	1	30	0.00	0.00	2301.
3	1	60	0.00	0.00	1898.
3	2	30	0.00	0.00	1567.
3	2	60	0.00	0.00	1286.
3	3	30	0.00	0.00	1057.
3	3	60	0.00	0.00	869.
3	4	30	0.00	0.00	717.
3	4	60	0.00	0.00	590.
3	5	30	0.00	0.00	488.
3	5	60	0.00	0.00	374.
3	6	30	0.00	0.00	283.
3	6	60	0.00	0.00	241.
3	7	30	0.00	0.00	208.
3	7	60	0.00	0.00	185.
3	8	30	0.00	0.00	167.
3	8	60	0.00	0.00	165.
3	9	30	0.00	0.00	164.
3	9	60	0.00	0.00	163.
3	10	30	0.00	0.00	163.
3	10	60	0.00	0.00	162.
3	11	30	0.00	0.00	162.
3	11	60	0.00	0.00	161.
3	12	30	0.02	0.00	161.
3	12	60	0.02	0.00	161.
3	13	30	0.03	0.00	161.
3	13	60	0.03	0.00	161.
3	14	30	0.04	0.00	161.
3	14	60	0.04	0.00	161.
3	15	30	0.09	0.02	164.
3	15	60	0.09	0.02	173.
3	16	30	0.03	0.00	188.
3	16	60	0.03	0.00	206.
3	17	30	0.03	0.00	223.
3	17	60	0.03	0.00	235.
3	18	30	0.00	0.00	238.
3	18	60	0.00	0.00	233.
3	19	30	0.00	0.00	222.
3	19	60	0.00	0.00	210.
3	20	30	0.00	0.00	200.
3	20	60	0.00	0.00	193.
3	21	30	0.00	0.00	186.
3	21	60	0.00	0.00	181.
3	22	30	0.00	0.00	177.

1	4	60	0.00	0.00	160.
1	5	30	0.00	0.00	160.
1	5	60	0.00	0.00	160.
1	6	30	0.01	0.00	160.
1	6	60	0.01	0.00	160.
1	7	30	0.01	0.00	160.
1	7	60	0.01	0.00	160.
1	8	30	0.01	0.00	160.
1	8	60	0.01	0.00	160.
1	9	30	0.01	0.00	160.
1	9	60	0.01	0.00	160.
1	10	30	0.01	0.00	161.
1	10	60	0.01	0.00	161.
1	11	30	0.01	0.00	161.
1	11	60	0.01	0.00	161.
1	12	30	0.05	0.00	161.
1	12	60	0.05	0.00	161.
1	13	30	0.06	0.00	161.
1	13	60	0.06	0.00	161.
1	14	30	0.07	0.00	161.
1	14	60	0.07	0.00	162.
1	15	30	0.18	0.00	162.
1	15	60	0.18	0.10	178.
1	16	30	0.07	0.00	219.
1	16	60	0.07	0.00	272.
1	17	30	0.05	0.00	328.
1	17	60	0.05	0.00	374.
1	18	30	0.01	0.00	397.
1	18	60	0.01	0.00	395.
1	19	30	0.01	0.00	366.
1	19	60	0.01	0.00	326.
1	20	30	0.01	0.00	294.
1	20	60	0.01	0.00	269.
1	21	30	0.01	0.00	248.
1	21	60	0.01	0.00	231.
1	22	30	0.01	0.00	217.
1	22	60	0.01	0.00	206.
1	23	30	0.01	0.00	197.
1	23	60	0.01	0.00	190.
2	0	30	0.05	0.00	184.
2	0	60	0.05	0.00	180.
2	1	30	0.05	0.00	176.
2	1	60	0.05	0.00	174.
2	2	30	0.05	0.00	171.
2	2	60	0.05	0.00	170.
2	3	30	0.05	0.00	169.
2	3	60	0.05	0.00	168.
2	4	30	0.05	0.00	167.
2	4	60	0.05	0.00	166.
2	5	30	0.05	0.00	166.
2	5	60	0.05	0.00	166.
2	6	30	0.15	0.07	174.
2	6	60	0.15	0.07	213.
2	7	30	0.15	0.07	289.
2	7	60	0.15	0.07	404.
2	8	30	0.15	0.07	551.
2	8	60	0.15	0.07	715.
2	9	30	0.15	0.07	877.
2	9	60	0.15	0.07	1018.
2	10	30	0.15	0.07	1133.
2	10	60	0.15	0.07	1225.
2	11	30	0.15	0.07	1299.
2	11	60	0.15	0.07	1359.
2	12	30	0.78	0.70	1501.
2	12	60	0.78	0.70	1880.
2	13	30	0.93	0.86	2602.

****
HEC-1 VERSION DATED JAN 1973
UPDATED AUG 74
CHANGE NO. 01
****

SPILLWAY DESIGN FLOOD
PARAN LAKE DAM
PHASE I DAM SAFETY INVESTIGATION

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
144	0	30	1	0	0	0	2	0	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

PROBABLE MAXIMUM 24-HOUR PRECIPITATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	15.60	0.0	15.60	0.0	0.500	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	18.00	106.00	118.00	129.00	137.00	141.00	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.815

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.70	0.15	0.0	0.00

UNIT HYDROGRAPH DATA
TP= 3.00 CP=0.68 NTA= 0

RECESSION DATA
STRTQ= 160.00 QRCSN= 160.00 RTIOR= 1.00

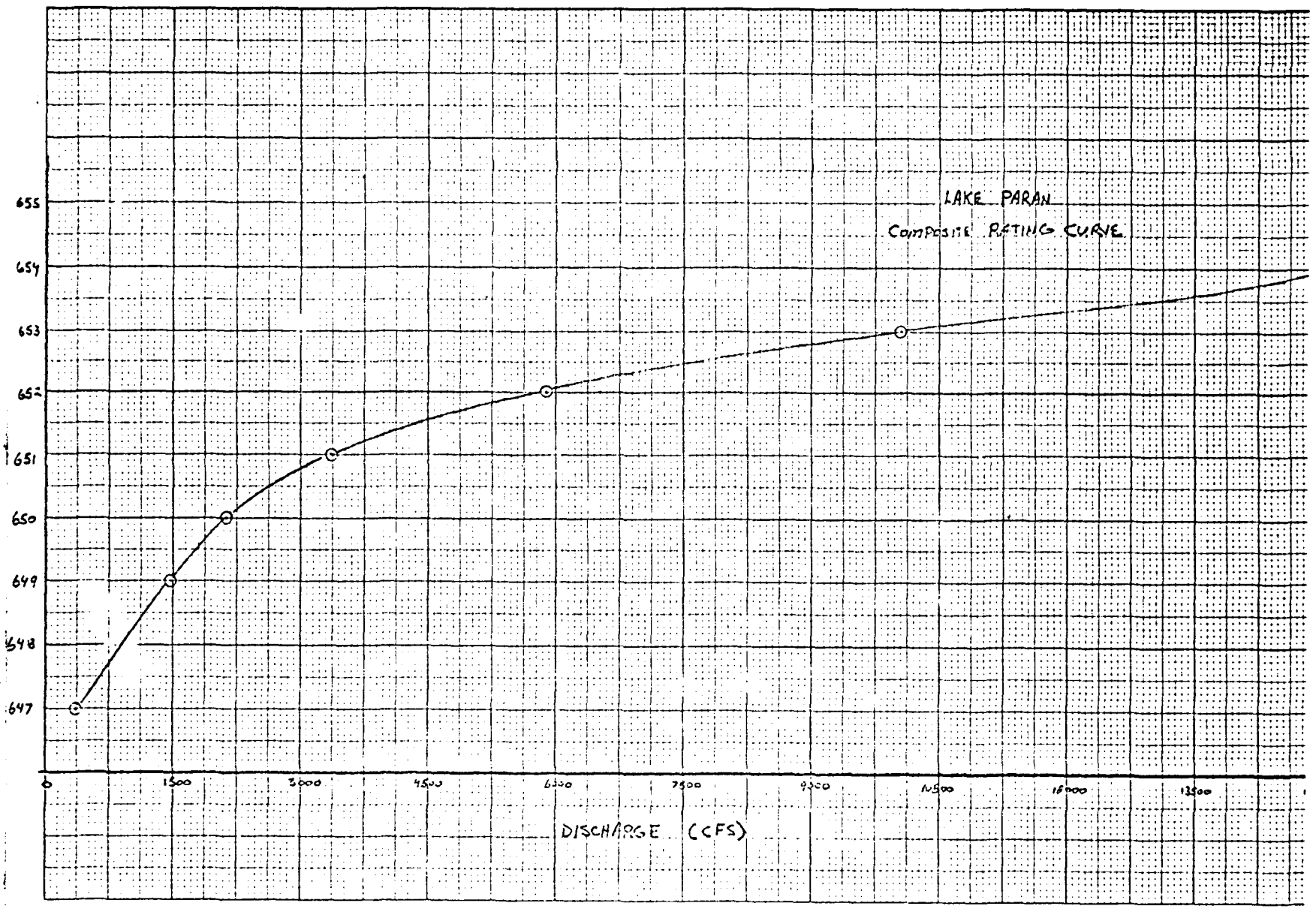
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 7.01 AND R= 4.67 INTERVALS

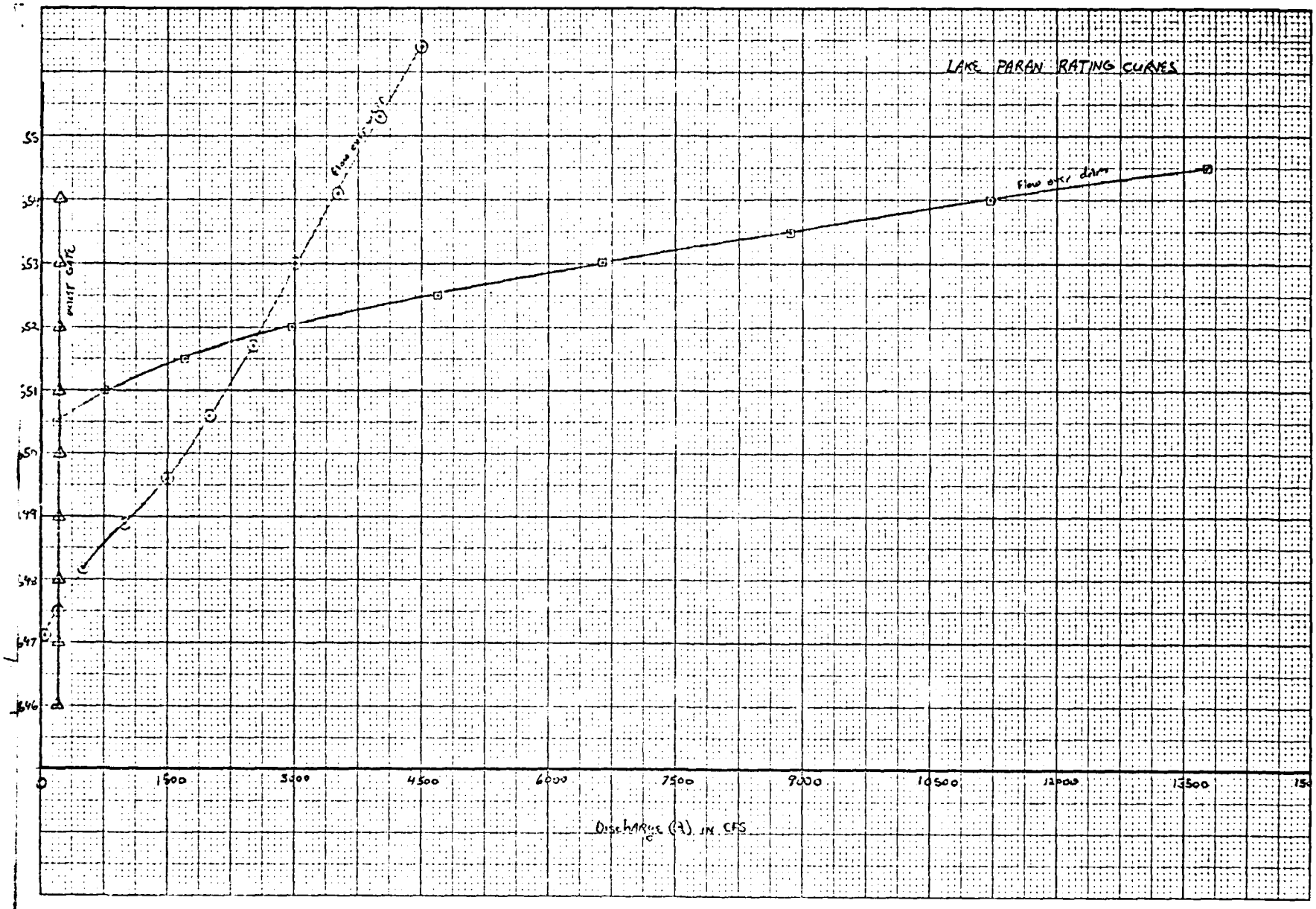
UNIT HYDROGRAPH 29 END-OF-PERIOD ORDINATES, LAG= 2.99 HOURS, CP= 0.67 VOL= 1.00

148.	539.	1057.	1636.	2048.	2276.	2258.	1971.	1590.	1282.
1034.	834.	673.	543.	438.	353.	285.	230.	185.	149.
121.	97.	78.	63.	51.	41.	33.	27.	22.	

END-OF-PERIOD FLOW

	TIME	RAIN	EXCS	COMP Q
1	0 30	0.00	0.00	160.
1	0 60	0.00	0.00	160.
1	1 30	0.00	0.00	160.
1	1 60	0.00	0.00	160.
1	2 30	0.00	0.00	160.
1	2 60	0.00	0.00	160.
1	3 30	0.00	0.00	160.
1	3 60	0.00	0.00	160.
1	4 30	0.00	0.00	160.


LAKE PARAN
COMPOSITE RATING CURVE
655
654
653
652
651
650
649
648
647
0
1500
3000
4500
6000
7500
9000
10500
12000
13500
DISCHARGE (CFS)


LAKE PARAN RATING CURVES
Flow over dam
Flow over dam
Sluice gate
653
652
651
650
649
648
647
646
0
1500
3000
4500
6000
7500
9000
10500
12000
13500
Discharge (Q) in CFS

DUFRESNE-HENRY ENGINEERING CORPORATION

BY _____ SUBJECT _____ SHEET NO. ____ OF ____

DATE _____ _____ JOB NO. _____

Total Q

Elevation	Pipe	Weir	Dam	Total
647	= 365 +	0		= 365
648	= 390 +	425		= 815
649	= 400 +	1075		= 1475
650	= 420 +	1700		= 2120
651	= 435 +	2180 +	750	= 3365
652	= 450 +	2610 +	2850	= 5910
653	= 465 +	3000 +	6600	= 10 065
654	= 480 +	3450 +	11,100	= 15030

UMMARY PRINTOUT FOR MULTIPLE PROFILES

AT: G CURVE

SECTION NUMBER	CHANNEL LENGTH	MIN EL OF ROADWAY	MAX EL OF LOW CHORD	MIN EL GROUND	DISCHARGE (CFS)	CWSEL	CRWS	EG	TOPWID	10K*S	TIME	VOL
1.00	0.0	0.0	0.0	641.80	3500.00	648.56	648.56	651.97	35.08	14.15	0.0	0.0
1.00	0.0	0.0	0.0	641.80	4000.00	649.20	649.20	652.91	35.10	13.93	0.0	0.0
1.00	0.0	0.0	0.0	641.80	4500.00	649.79	649.79	653.82	35.10	13.94	0.0	0.0
1.00	0.0	0.0	0.0	641.80	5000.00	650.37	650.37	654.69	35.10	13.86	0.0	0.0
2.10	29.00	0.0	0.0	641.80	3500.00	653.89	0.0	653.97	140.00	0.13	0.00	0.41
2.10	29.00	0.0	0.0	641.80	4000.00	655.01	0.0	655.09	140.00	0.12	0.00	0.45
2.10	29.00	0.0	0.0	641.80	4500.00	656.10	0.0	656.19	140.00	0.12	0.00	0.49
2.10	29.00	0.0	0.0	641.80	5000.00	657.14	0.0	657.23	140.00	0.11	0.00	0.53
2.20	1.00	646.80	0.0	644.30	3500.00	654.13	0.0	654.27	140.00	0.33	0.00	0.44
2.20	1.00	646.80	0.0	644.30	4000.00	655.26	0.0	655.41	140.00	0.29	0.00	0.49
2.20	1.00	646.80	0.0	644.30	4500.00	656.37	0.0	656.52	140.00	0.26	0.00	0.53
2.20	1.00	646.80	0.0	644.30	5000.00	657.43	0.0	657.58	140.00	0.23	0.00	0.57

SECTION NUMBER	DISCHARGE CFS	CWSEL	CWSEL DIFF EACH Q	CWSEL DIFF EACH SECTION	CWSEL-WSELK	TOPWID	T.W. DIFF	LENGTH
1.000	3500.000	648.560	0.0	0.0	0.0	35.080	0.0	0.0
1.000	4000.000	649.203	0.643	0.0	0.0	35.097	-0.017	0.0
1.000	4500.000	649.785	0.583	0.0	0.0	35.100	-0.020	0.0
1.000	5000.000	650.366	0.581	0.0	0.0	35.100	-0.020	0.0
2.100	3500.000	653.891	0.0	5.331	0.0	140.001	0.0	29.000
2.100	4000.000	655.008	1.117	5.805	0.0	140.001	-0.000	29.000
2.100	4500.000	656.100	1.092	6.314	0.0	140.001	-0.000	29.000
2.100	5000.000	657.141	1.041	6.774	0.0	140.002	-0.001	29.000
2.200	3500.000	654.130	0.0	0.239	0.0	140.001	0.0	1.000
2.200	4000.000	655.264	1.134	0.256	0.0	140.001	-0.000	1.000
2.200	4500.000	656.371	1.107	0.271	0.0	140.001	-0.000	1.000
2.200	5000.000	657.428	1.057	0.288	0.0	140.002	-0.001	1.000

DATA FOR LAST CROSS SECTION

PROFILE	TYPE ENC	TARGET	TOP WIDTH AREA-ACRES	TOP WIDTH AREA-DIFF
1	0.0	0.0	0.045	0.0
2	0.0	0.0	0.045	0.000
3	0.0	0.0	0.045	0.000
4	0.0	0.0	0.045	0.000

2.100	1000.000	646.928	1.934	2.197	0.0	90.000	0.0	29.000
2.100	1500.000	648.539	1.611	2.894	0.0	90.000	0.0	29.000
2.100	2000.000	650.125	1.586	3.672	0.0	140.000	-50.000	29.000
2.100	2500.000	651.453	1.328	4.241	0.0	140.000	-50.000	29.000
2.100	3000.000	652.709	1.257	4.811	0.0	140.001	-50.001	29.000
2.200	50.000	647.091	0.0	4.080	0.0	89.970	0.0	1.000
2.200	100.000	647.267	0.176	4.131	0.0	89.974	-0.004	1.000
2.200	200.000	647.545	0.278	4.212	0.0	89.981	-0.011	1.000
2.200	500.000	648.152	0.608	3.159	0.0	89.996	-0.027	1.000
2.200	1000.000	648.913	0.761	1.986	0.0	90.000	-0.030	1.000
2.200	1500.000	649.599	0.686	1.060	0.0	140.000	-50.030	1.000
2.200	2000.000	650.556	0.957	0.431	0.0	140.000	-50.030	1.000
2.200	2500.000	651.710	1.155	0.257	0.0	140.000	-50.031	1.000
2.200	3000.000	652.951	1.241	0.241	0.0	140.001	-50.031	1.000

DATA FOR LAST CROSS SECTION

PROFILE	TYPE ENC	TARGET	TOP WIDTH AREA-ACRES	TOP WIDTH AREA-DIFF
1	0.0	0.0	0.044	0.0
2	0.0	0.0	0.044	0.000
3	0.0	0.0	0.044	0.000
4	0.0	0.0	0.044	0.000
5	0.0	0.0	0.044	0.000
6	0.0	0.0	0.044	0.001
7	0.0	0.0	0.045	0.001
8	0.0	0.0	0.045	0.001
9	0.0	0.0	0.045	0.001

SUMMARY PRINTOUT FOR MULTIPLE PROFILES

RATING CURVE

SEC NUM	ON R	CHANNEL LENGTH	MIN EL OF ROADWAY	MAX EL OF LOW CHORD	MIN EL GROUND	DISCHARGE %CFS<	CWSEL	CRIWS	EG	TOPWID	10K*S	TIME	VOL
→	1.00	0.0	0.0	0.0	641.80	50.00	642.20	642.20	642.40	34.91	28.95	0.0	0.0
	1.00	0.0	0.0	0.0	641.80	100.00	642.43	642.43	642.75	34.92	25.33	0.0	0.0
	1.00	0.0	0.0	0.0	641.80	200.00	642.80	642.80	643.31	34.93	21.96	0.0	0.0
	1.00	0.0	0.0	0.0	641.80	500.00	643.64	643.64	644.58	34.95	18.69	0.0	0.0
	1.00	0.0	0.0	0.0	641.80	1000.00	644.73	644.73	646.21	34.98	16.51	0.0	0.0
	1.00	0.0	0.0	0.0	641.80	1500.00	645.64	645.64	647.58	35.00	15.51	0.0	0.0
	1.00	0.0	0.0	0.0	641.80	2000.00	646.45	646.45	648.80	35.02	15.00	0.0	0.0
	1.00	0.0	0.0	0.0	641.80	2500.00	647.21	647.21	649.93	35.04	14.51	0.0	0.0
	1.00	0.0	0.0	0.0	641.80	3000.00	647.90	647.90	650.98	35.06	14.35	0.0	0.0
→	2.10	29.00	0.0	0.0	642.80	50.00	643.01	643.01	643.12	90.00	35.75	0.00	0.01
	2.10	29.00	0.0	0.0	642.80	100.00	643.14	643.14	643.30	90.00	30.40	0.00	0.02
	2.10	29.00	0.0	0.0	642.80	200.00	643.33	643.33	643.60	90.00	26.12	0.00	0.03
	2.10	29.00	0.0	0.0	642.80	500.00	644.99	643.78	645.09	90.00	1.48	0.00	0.09
	2.10	29.00	0.0	0.0	642.80	1000.00	646.93	0.0	647.04	90.00	0.71	0.00	0.16
	2.10	29.00	0.0	0.0	642.80	1500.00	648.54	0.0	648.67	90.00	0.54	0.00	0.23
	2.10	29.00	0.0	0.0	642.80	2000.00	650.12	0.0	650.16	140.00	0.16	0.00	0.27
	2.10	29.00	0.0	0.0	642.80	2500.00	651.45	0.0	651.52	140.00	0.15	0.00	0.32
	2.10	29.00	0.0	0.0	642.80	3000.00	652.71	0.0	652.78	140.00	0.14	0.00	0.36
→	2.20	1.00	646.80	0.0	644.30	50.00	647.09	0.0	647.09	89.97	0.01	0.00	0.01
	2.20	1.00	646.80	0.0	644.30	100.00	647.27	0.0	647.27	89.97	0.02	0.00	0.02
	2.20	1.00	646.80	0.0	644.30	200.00	647.54	0.0	647.55	89.98	0.07	0.00	0.03
	2.20	1.00	646.80	0.0	644.30	500.00	648.15	0.0	648.18	90.00	0.24	0.00	0.04
	2.20	1.00	646.80	0.0	644.30	1000.00	648.91	0.0	649.00	90.00	0.53	0.00	0.12
	2.20	1.00	646.80	0.0	644.30	1500.00	649.60	0.0	649.73	140.00	0.66	0.00	0.20
	2.20	1.00	646.80	0.0	644.30	2000.00	650.56	0.0	650.71	140.00	0.62	0.00	0.27
	2.20	1.00	646.80	0.0	644.30	2500.00	651.71	0.0	651.86	140.00	0.50	0.00	0.33
	2.20	1.00	646.80	0.0	644.30	3000.00	652.95	0.0	653.10	140.00	0.40	0.00	0.40

SECTION NUMBER	DISCHARGE CFS	CWSEL	CWSEL DIFF EACH Q	CWSEL DIFF EACH SECTION	CWSEL-WSELK	TOPWID	T.W. DIFF	LENGTH
1.000	50.000	642.199	0.0	0.0	0.0	34.911	0.0	0.0
1.000	100.000	642.431	0.232	0.0	0.0	34.917	-0.006	0.0
1.000	200.000	642.803	0.372	0.0	0.0	34.927	-0.016	0.0
1.000	500.000	643.642	0.838	0.0	0.0	34.949	-0.038	0.0
1.000	1000.000	644.730	1.089	0.0	0.0	34.978	-0.068	0.0
1.000	1500.000	645.645	0.914	0.0	0.0	35.003	-0.092	0.0
1.000	2000.000	646.452	0.808	0.0	0.0	35.024	-0.113	0.0
1.000	2500.000	647.212	0.760	0.0	0.0	35.044	-0.134	0.0
1.000	3000.000	647.899	0.687	0.0	0.0	35.063	-0.152	0.0
2.100	50.000	643.011	0.0	0.812	0.0	90.000	0.0	29.000
2.100	100.000	643.136	0.125	0.705	0.0	90.000	0.0	29.000
2.100	200.000	643.333	0.197	0.530	0.0	90.000	0.0	29.000
2.100	500.000	644.993	1.660	1.352	0.0	90.000	0.0	29.000

DUFRESNE-HENRY ENGINEERING CORPORATION

BY _____ SUBJECT Rating Curve for Weir at Lake O Paron SHEET NO. ____ OF ____

DATE _____ JOB NO. _____

Lake Elevation	Discharge
647.1	50
647.3	100
647.5	200
648.2	500
648.9	1000
649.6	1500
650.6	2000
651.7	2500
653.	3000
654.1	3500
655.3	4000
656.4	4500
657.4	5000

Note: This analysis was performed by means of the HEC-2 computer program. Analysis takes into account weir submergence by the formation of a standing wave at the constriction in the flume. Another HEC-2 run was prepared to check for obstruction by the Rutland Railroad bridge which does not pose a hazard.

DUFRESNE-HENRY ENGINEERING CORPORATION

BY E J Flakin SUBJECT Rating Curve for Outlet Gate of Lake Paran SHEET NO. ____ OF ____

DATE 07/10/78 JOB NO. ____

Note: data is incomplete for a full analysis of the structure as the detailed plans do not cover the tail of the outlet. Thus it will be assumed that inlet control dominates and also that the actual inlet is the 4'x5½' box conduit and the gate opening sans 20° wingwalls. All measurements of elevation are based on the assumed lake level of 647±, all calculations are based on Hydraulic Engineering Circular #5, (1965) by the Bureau of Public Roads.

Lake Elevation	HW/D	Q/B	Q
646	2.7	86	345 cfs
647	2.9	91	365 cfs
648	3.2	97	390 cfs
649	3.4	100	400 cfs
650	3.7	105	420 cfs
651	3.9	109	435 cfs
652	4.2	112	450 cfs
653	4.4	116	465 cfs
654	4.7	120	480 cfs

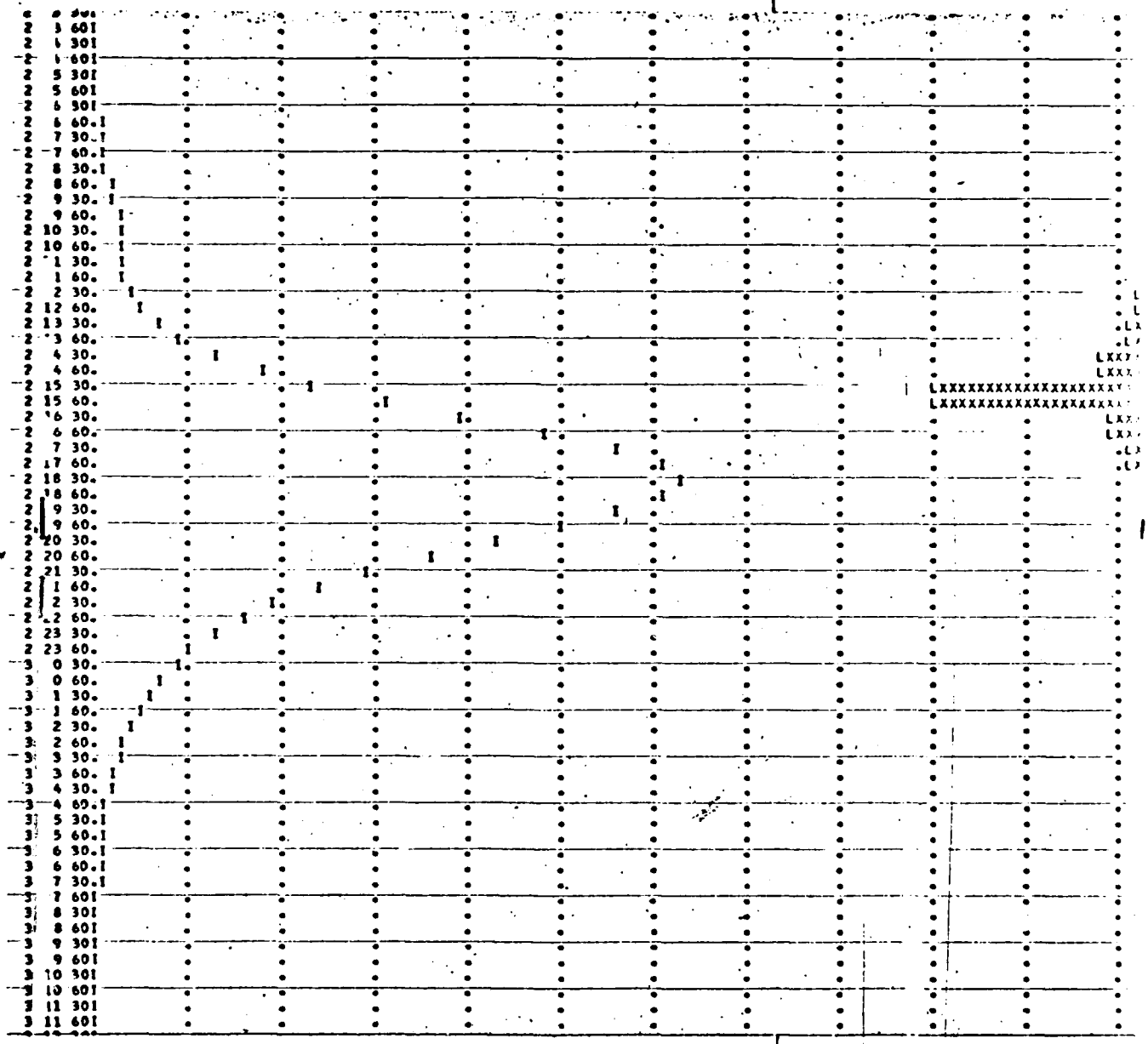
DUFRESNE-HENRY ENGINEERING CORPORATION

BY EJ (Asst) SUBJECT Lake Paran Dam (Rating Curve SHEET NO. ____ OF ____
DATE 07/10/78 JOB NO. ____

Discharge over the top of the Dam

$Q = CLH^{3/2} \Rightarrow CAH^{1/2}$

Lake Elevation	Weir Length (L)	Area (A)	Head (Ave)	C	Q
650.5	335'	111 sq ft	0.33	3.	190 cfs
651.0	940'	302 sq ft	0.69	3.	750 cfs
651.5	515'	552 sq ft	1.07	3.	1715 cfs
652	597'	833 sq ft	1.4	3.	2950 cfs
652.5	597'	1132 sq ft	1.9	3.	4675 cfs
653	597	1430 sq ft	2.4	3.	6640 cfs
653.5	597	1729 sq ft	2.9	3.	8830 cfs
654	597	2027 sq ft	3.4	3.	11205 cfs
654.5	597	2325 sq ft	3.9	3.	13770 cfs
655.	597	2624 sq ft	4.4	3.	16505 cfs
655.5	597	2923 sq ft	4.9	3.	19400 cfs
656	597	3221 sq ft	5.4	3.	22445 cfs
656.5	597	3520 sq ft	5.9	3.	25640 cfs



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3	1	30I
3	1	60I
3	14	30I
3	14	60I
3	1	30I
3	1	60I
3	1	30I
3	16	60.I
3	17	30.I
3	1	60.I
3	1	30.I
3		60.I
3	19	30.I
3	19	60.I
3		30.I
3		60I
3		30I
3	21	60I
3	22	30I
3		60I
3		30I
3		60I

RUNOFF MULTIPLIED BY 0.50

80.	80.	80.	80.	80.	80.	80.	80.	80.	80.
80.	80.	80.	80.	80.	80.	80.	80.	80.	80.
80.	80.	80.	80.	80.	80.	80.	81.	81.	81.
81.	89.	109.	136.	164.	187.	199.	198.	183.	163.
147.	134.	124.	115.	109.	103.	99.	95.	92.	90.
88.	87.	86.	85.	84.	84.	84.	83.	83.	83.
87.	106.	144.	202.	276.	357.	438.	509.	566.	612.
649.	679.	750.	940.	1301.	1862.	2618.	3532.	4666.	6139.
7867.	9626.	11170.	12239.	12646.	12276.	11255.	9927.	8515.	7116.
5825.	4725.	3837.	3122.	2544.	2079.	1703.	1398.	1151.	949.
784.	643.	529.	434.	358.	295.	244.	187.	141.	121.
104.	93.	83.	83.	82.	82.	81.	81.	81.	81.
81.	80.	80.	80.	80.	80.	82.	86.	96.	103.
112.	117.	119.	116.	111.	105.	100.	96.	93.	91.
89.	87.	86.	85.						

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12646.	9550.	3332.	1174.	169114.
INCHES		5.69	7.95	8.40	8.40
AC-FT		4738.	6613.	6992.	6992.

JVF*

STATION 1

INFLOW*I<, OUTFLOW*O< AND OBSERVED FLOW*0<

0. 2000. 4000. 6000. 8000. 10000. 12000. 14000. 0. 0. 0. 0.

1 0 301
1 601
1 301
1 601
1 2 301
1 2 601
1 301
1 601
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1 4 601
1 5 301
1 601
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1 601
1 7 301
1 7 601
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1 9 601
1 10 301
1 10 601
1 301
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1 12 301
1 12 601
1 13 301
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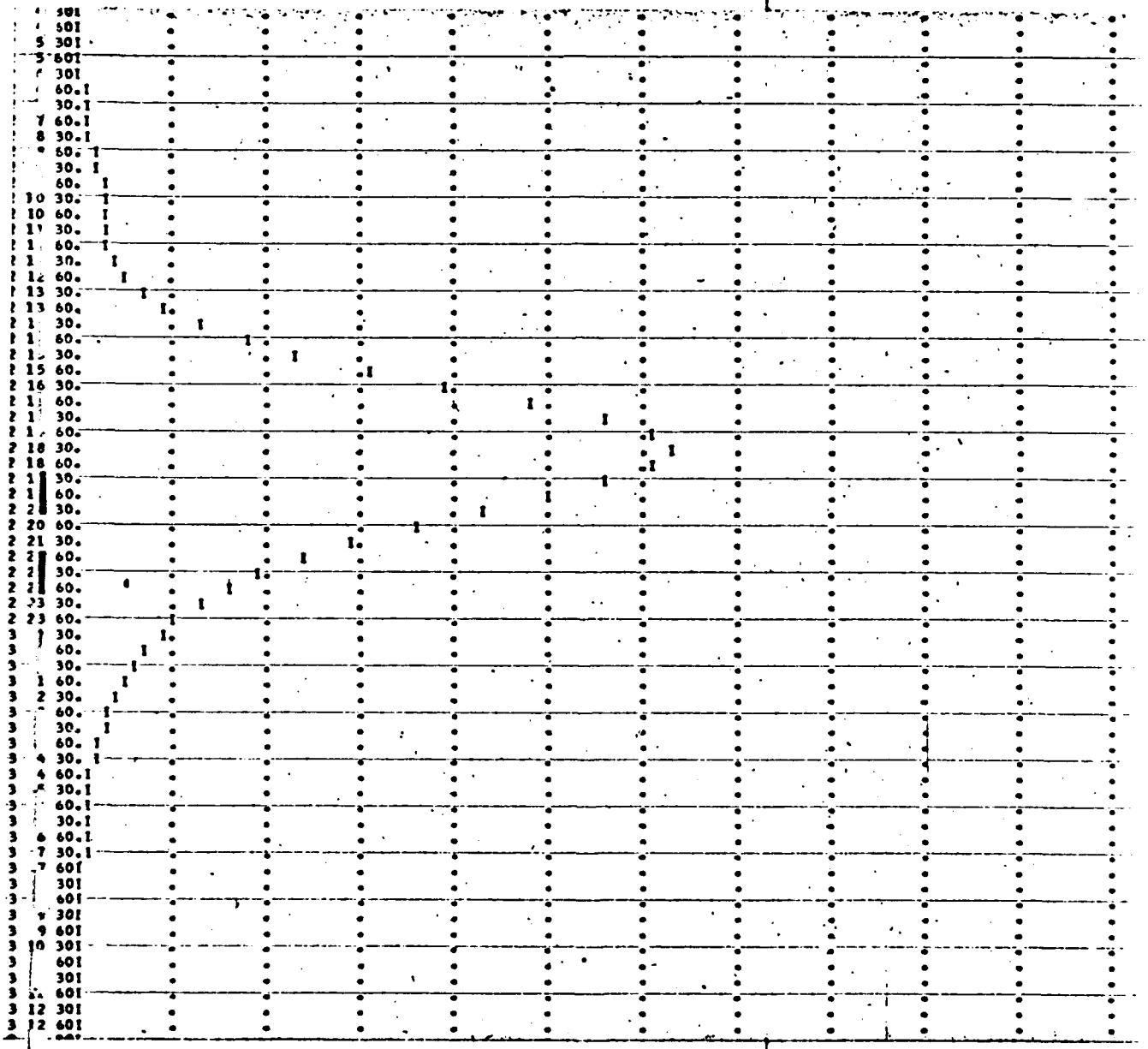
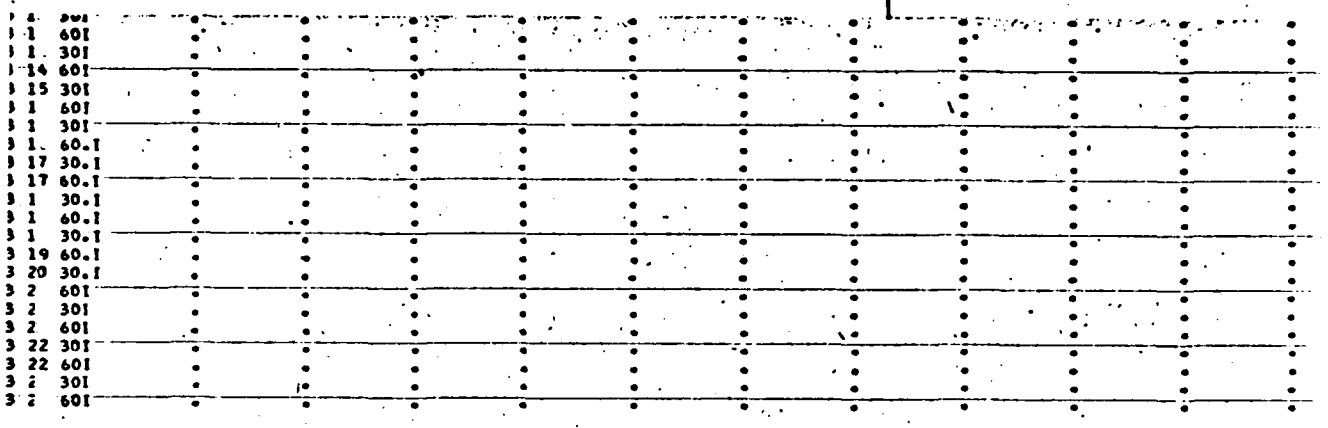
1 301
1 14 601
1 15 301
1 15 601
1 30.1
1 60.1
1 17 30.1
1 17 60.1
1 18 30.1
1 60.1
1 30.1
1 60.1
1 20 30.1
1 20 60.1
1 1 30.1
1 1 60.1
1 2 30.1
1 22 60.1
1 23 301
1 3 601
2 3 301
2 3 601
2 1 301
2 1 601
2 2 301
2 2 601
2 3 301
2 3 601

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3 1 60.1
3 1 30.1
3 19 60.1
3 20 30.1
3 2 601
3 2 301
3 2 601
3 22 301
3 22 601
3 2 301
3 2 601

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

PULS RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.0	0.0	0.0	-1.

STORAGE	252.	259.	295.	331.	367.	403.	439.	475.	496.	511.
OUTFLOW	0.	365.	815.	1475.	2120.	3365.	5910.	10065.	13500.	15030.

	TIME	EOP STOR	AVG IN	EOP OUT
1	0 30	254.	80.	80.
1	0 60	254.	80.	80.
1	1 30	254.	80.	80.
1	1 60	254.	80.	80.
1	2 30	254.	80.	80.
1	2 60	254.	80.	80.
1	3 30	254.	80.	80.
1	3 60	254.	80.	80.
1	4 30	254.	80.	80.
1	4 60	254.	80.	80.
1	5 30	254.	80.	80.
1	5 60	254.	80.	80.
1	6 30	254.	80.	80.
1	6 60	254.	80.	80.
1	7 30	254.	80.	80.
1	7 60	254.	80.	80.
1	8 30	254.	80.	80.
1	8 60	254.	80.	80.
1	9 30	254.	80.	80.
1	9 60	254.	80.	80.
1	10 30	254.	80.	80.
1	10 60	254.	80.	80.
1	11 30	254.	80.	80.
1	11 60	254.	80.	80.
1	12 30	254.	80.	80.
1	12 60	254.	80.	80.
1	13 30	254.	80.	80.
1	13 60	254.	80.	80.
1	14 30	254.	81.	81.
1	14 60	254.	81.	81.
1	15 30	254.	81.	81.
1	15 60	254.	85.	85.
1	16 30	254.	99.	100.
1	16 60	254.	123.	124.
1	17 30	255.	150.	151.
1	17 60	255.	176.	176.
1	18 30	256.	193.	193.
1	18 60	256.	198.	198.
1	19 30	256.	190.	190.
1	19 60	255.	173.	172.

1	20	30	255.	142.	142.
1	20	60	255.	141.	140.
1	21	30	254.	129.	129.
1	21	60	254.	120.	119.
1	22	30	254.	112.	112.
1	22	60	254.	106.	106.
1	23	30	254.	101.	101.
1	23	60	254.	97.	97.
2	0	30	254.	94.	94.
2	0	60	254.	91.	91.
2	1	30	254.	89.	89.
2	1	60	254.	87.	87.
2	2	30	254.	86.	86.
2	2	60	254.	85.	85.
2	3	30	254.	85.	85.
2	3	60	254.	84.	84.
2	4	30	254.	84.	84.
2	4	60	254.	83.	83.
2	5	30	254.	83.	83.
2	5	60	254.	83.	83.
2	6	30	254.	85.	85.
2	6	60	254.	97.	97.
2	7	30	254.	125.	126.
2	7	60	255.	173.	175.
2	8	30	257.	239.	241.
2	8	60	258.	317.	319.
2	9	30	260.	398.	379.
2	9	60	263.	474.	418.
2	10	30	267.	538.	467.
2	10	60	271.	589.	517.
2	11	30	275.	631.	564.
2	11	60	278.	664.	605.
2	12	30	282.	715.	650.
2	12	60	288.	845.	730.
2	13	30	301.	1120.	916.
2	13	60	320.	1581.	1282.
2	14	30	349.	2240.	1803.
2	14	60	384.	3075.	2691.
2	15	30	413.	4099.	4076.
2	15	60	435.	5403.	5651.
2	16	30	453.	7003.	7508.
2	16	60	468.	8747.	9253.
2	17	30	480.	10398.	10943.
2	17	60	488.	11704.	12118.
2	18	30	491.	12443.	12619.
2	18	60	489.	12461.	12375.
2	19	30	483.	11765.	11434.
2	19	60	475.	10591.	10133.
2	20	30	464.	9221.	8642.
2	20	60	452.	7816.	7396.
2	21	30	441.	6470.	6092.
2	21	60	427.	5275.	5093.
2	22	30	414.	4281.	4129.
2	22	60	403.	3479.	3360.
2	23	30	390.	2833.	2921.
2	23	60	375.	2311.	2413.
3	0	30	362.	1891.	2028.
3	0	60	347.	1550.	1770.
3	1	30	333.	1274.	1502.
3	1	60	319.	1050.	1254.
3	2	30	307.	866.	1041.
3	2	60	298.	713.	861.
3	3	30	289.	586.	736.
3	3	60	280.	481.	632.
3	4	30	273.	396.	535.
3	4	60	266.	327.	450.

3	5	30	260.	269.	278.
3	5	60	256.	216.	226.
3	6	30	255.	164.	162.
3	6	60	254.	131.	130.
3	7	30	254.	112.	112.
3	7	60	254.	98.	98.
3	8	30	254.	88.	88.
3	8	60	254.	83.	83.
3	9	30	254.	82.	82.
3	9	60	254.	82.	82.
3	10	30	254.	82.	82.
3	10	60	254.	81.	81.
3	11	30	254.	81.	81.
3	11	60	254.	81.	81.
3	12	30	254.	81.	81.
3	12	60	254.	80.	80.
3	13	30	254.	80.	80.
3	13	60	254.	80.	80.
3	14	30	254.	80.	80.
3	14	60	254.	80.	80.
3	15	30	254.	81.	81.
3	15	60	254.	84.	84.
3	16	30	254.	90.	91.
3	16	60	254.	99.	99.
3	17	30	254.	107.	108.
3	17	60	254.	114.	115.
3	18	30	254.	118.	118.
3	18	60	254.	118.	118.
3	19	30	254.	114.	113.
3	19	60	254.	108.	108.
3	20	30	254.	103.	102.
3	20	60	254.	98.	98.
3	21	30	254.	95.	95.
3	21	60	254.	92.	92.
3	22	30	254.	90.	90.
3	22	60	254.	88.	88.
3	23	30	254.	86.	86.
3	23	60	254.	85.	85.
		SUM			169111.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12619.	9530.	3332.	1174.	169111.
INCHES		5.68	7.95	8.40	8.40
AC-FT		4728.	6612.	6992.	6992.

VF4

STATION 1

INFLOW=I<, OUTFLOW=O< AND OBSERVED FLOW=*<

			0.	2000.	4000.	6000.	8000.	10000.	12000.	14000.	0.	0.	0.	0.
1	0	301												
1	0	601												
1		301												
1		601												
1		301												
1	2	601												
1	3	301												
1		601												
1		301												
1		601												
1	5	301												
1	5	601												
1		301												
1		601												
1		301												
1		601												
1	8	301												
1		601												
1		301												
1		601												
1	10	301												
1	10	601												
1	11	301												
1		601												
1		301												
1		601												
1	13	301												
1	13	601												
1		301												
1		601												
1		301												
1	15	601												
1	16	301												
1		60.1												
1		30.1												
1		60.1												
1	18	30.1												
1	18	60.1												
1		30.1												
1		60.1												
1		30.1												
1	20	60.1												
1	21	30.1												
1		60.1												
1		30.1												
1		60.1												
1	23	30.1												
1	23	601												
2		301												
2		601												
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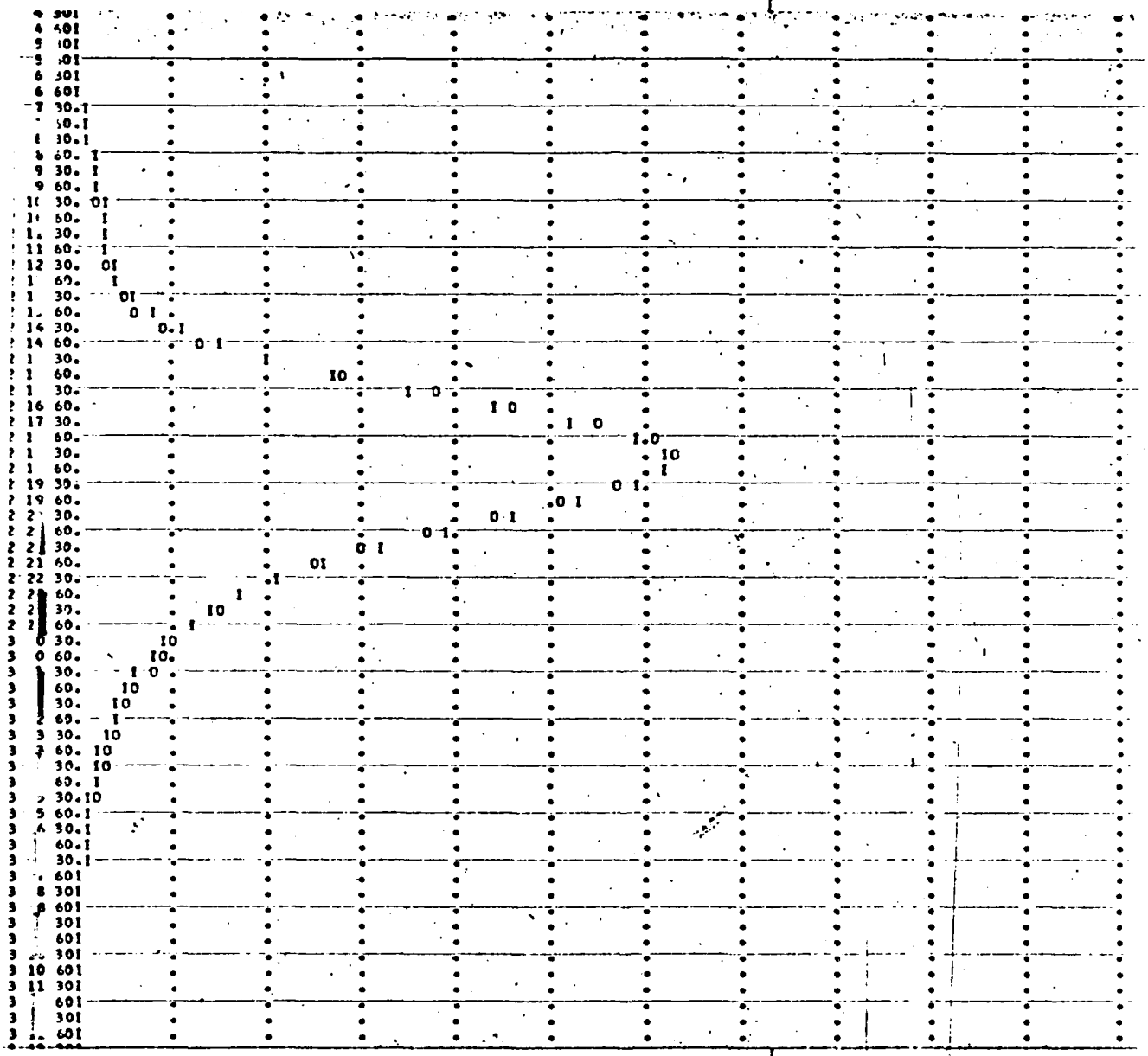
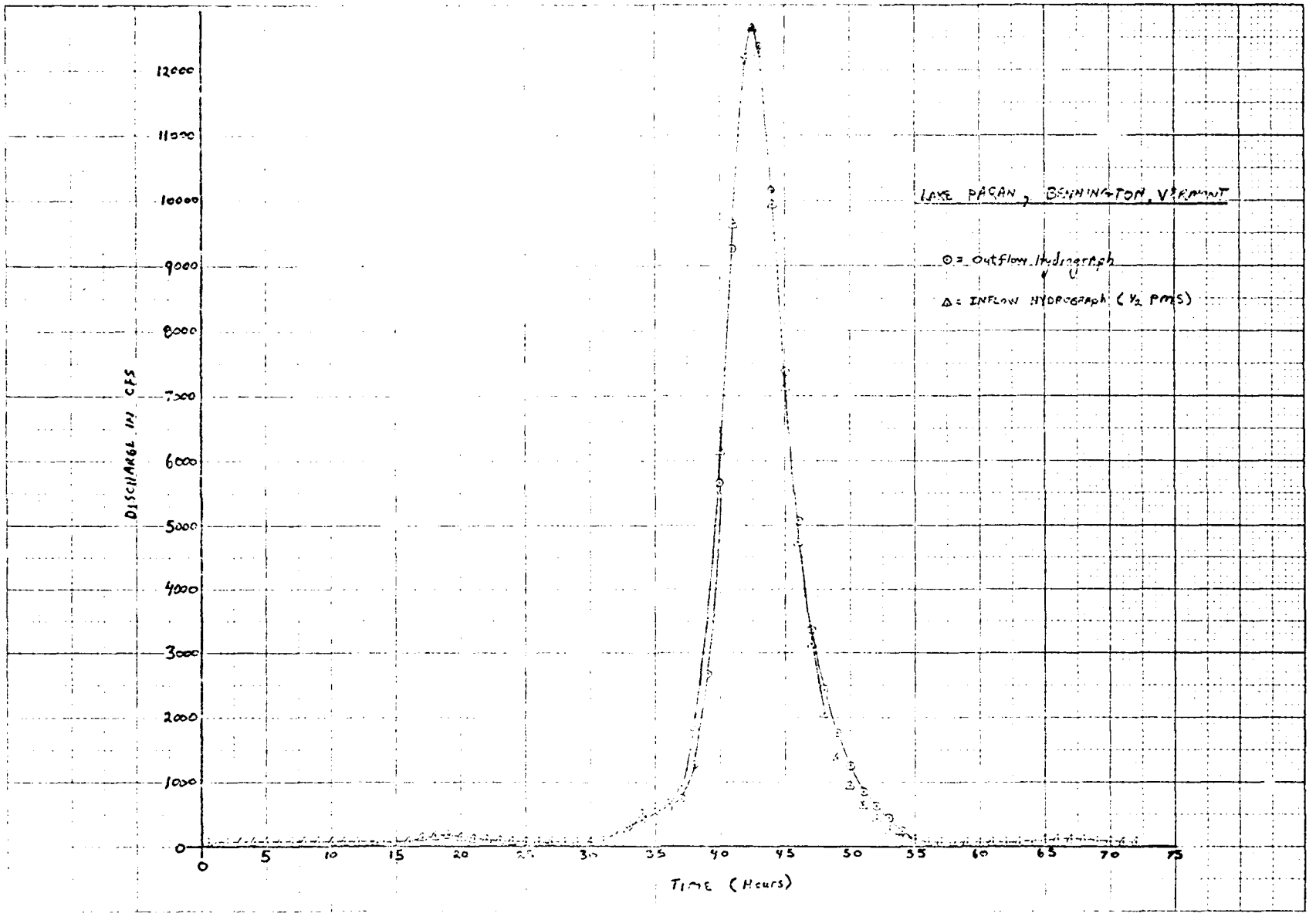
2	1	601												
2	2	301												
2		601												
2		301												
2		601												



```
3 13 60I
3  1  30I
3  1  60I
3  1. 30I
3 15 60I
3 16 30I
3  1  60I
3  1  30.I
3  1  60.I
3 18 30.I
3 18 60.I
3  1  30.I
3  1  60.I
3  2  30.I
3 20 60I
3 21 30I
3  2  60I
3  2  30I
3  2  60I
3 23 30I
3 23 60I
```

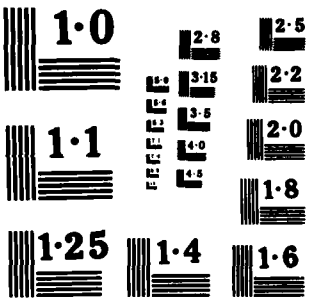
RUNOFF SUMMARY, AVERAGE FLOW

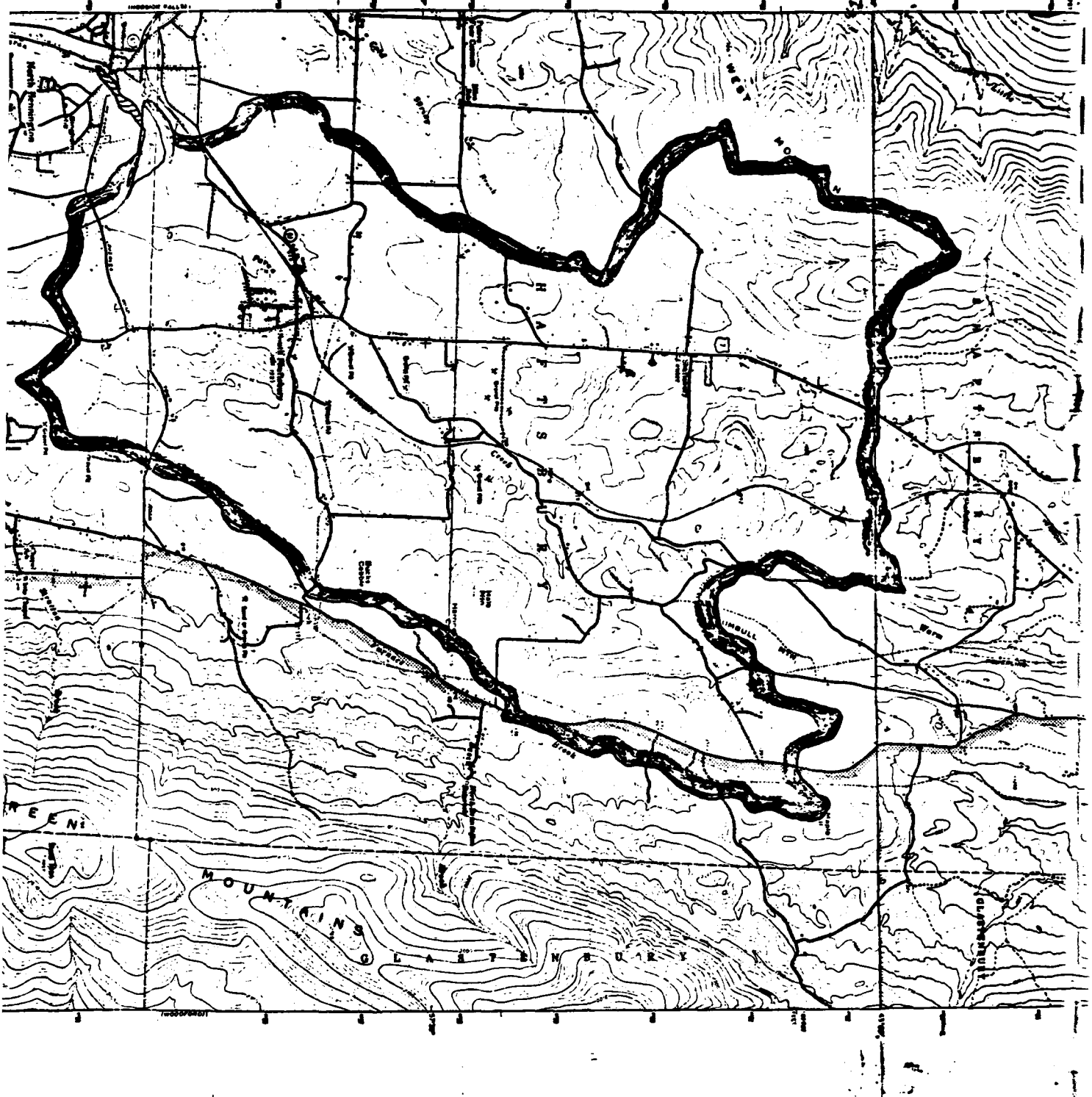
		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	12646.	9550.	3332.	1174.	15.60
ROUTED TO	1	12619.	9530.	3332.	1174.	15.60

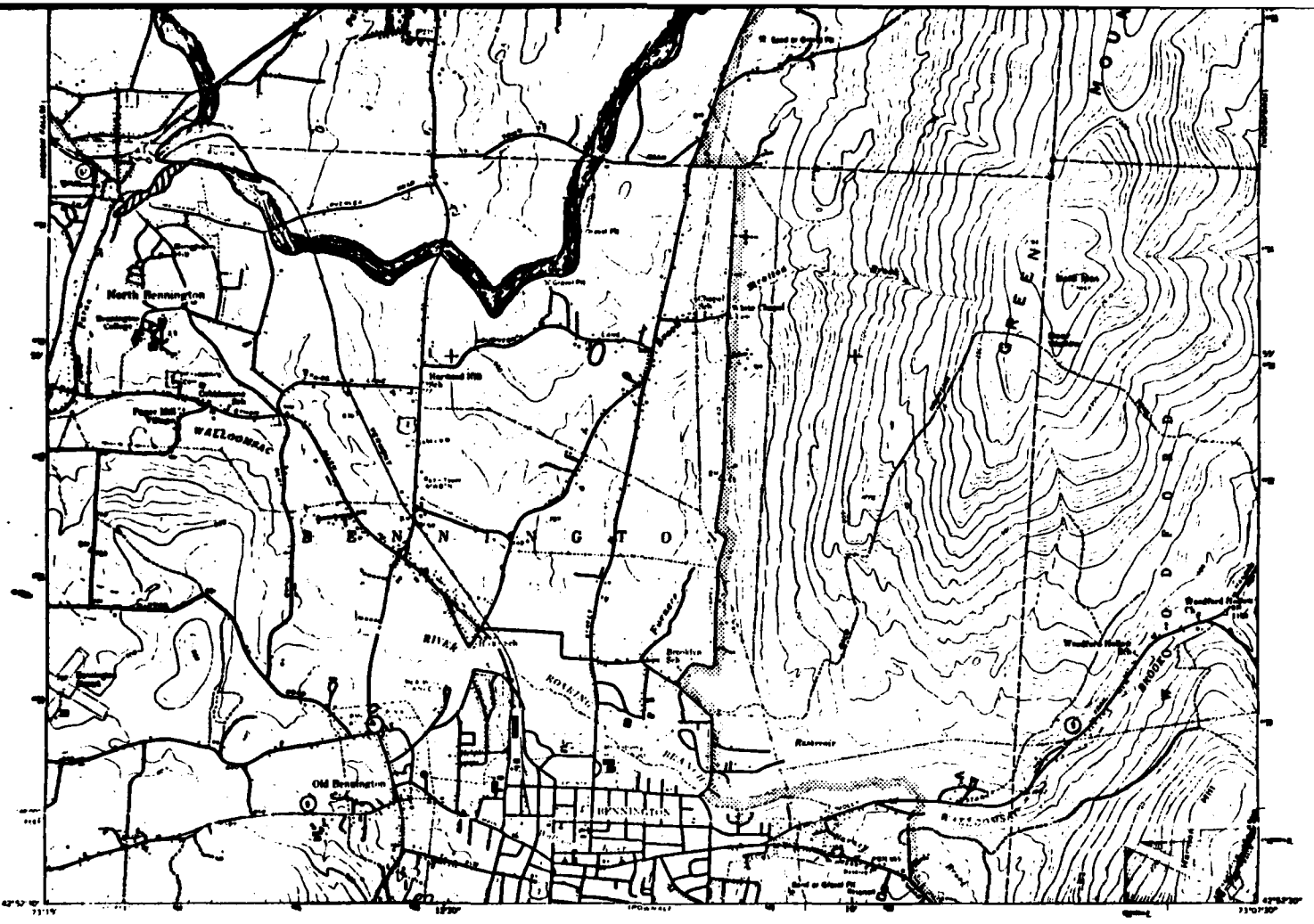

LAKE PACAN, BENNINGTON, VERMONT
○ = Outflow Hydrograph
△ = INFLOW HYDROGRAPH (½ PMS)
DISCHARGE IN CFS
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
TIME (Hours)

AD-A156 743 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS LAKE PARAN (VT 00006)..(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV AUG 78 2/2

UNCLASSIFIED F/G 13/13 NL


1·0
1·1
1·25
2·8
3·15
3·5
4·0
4·5
1·4
2·5
2·2
2·0
1·8
1·6


North Bennington
MOUNTAINS
GLASTENBURY



Polyconic Projection- 1927 North American Datum. 10,000 foot grid based on Vermont coordinate system and Massachusetts coordinate system mainland zone. 1,000 meter Universal Transverse Mercator grid shown in blue. Contour datum is mean sea level and indicated in 20 foot intervals.

Maps have been photomechanically reproduced and corrected to 1:31,680 scale from 1:24,000 and 1:62,500 scale U.S. Geological Survey Standard Surveyor quadrangle maps. Revisions by photogrammetric methods within National Forest areas only from 1:40,000 scale 1971 high altitude aerial photography. Field examination 1974 by:

Cheeseboro Unit
U.S. Forest Service, Eastern Region
Milwaukee, Wisconsin

Scale 1:31,680
0 ½ 1 2 MI.

LEGEND

- National Forest Boundary
- U.S. Highway
- State Highway
- Forest Route
- Forest Trail
- Paved Road
- All Weather Road
- Good Road
- Primitive Road
- Trail
- Long Trail and Appalachian Trail Locations as of September 1, 1974
- National Forest Land as of September 1, 1974

Forest Supervisor's Headquarters, Rutland, Vermont

VT
Bennington

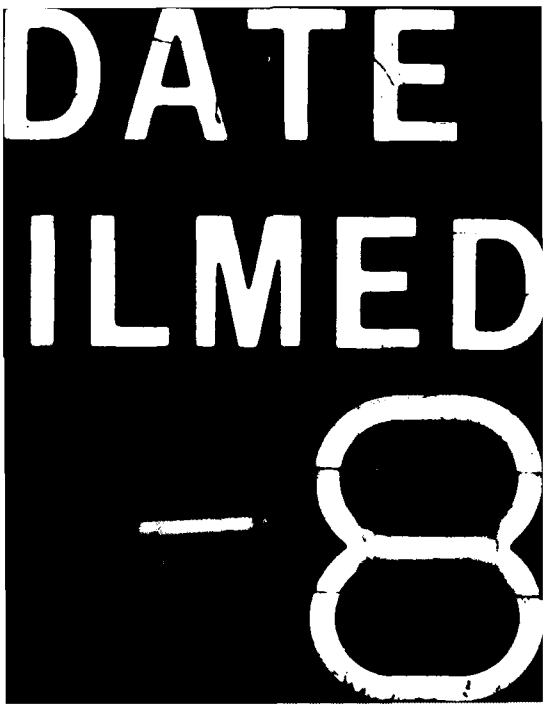
QUADRANGLE LOCATION

UTM GRID AND 1974 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

BENNINGTON, VERMONT
1975

APPENDIX E

Information as contained in the National Inventory of Dams


DATE
ILMED
-8